

N74-21160

PRODUCTION DEVELOPMENT OF ORGANIC  
NONFLAMMABLE SPACECRAFT POTTING  
ENCAPSULATING AND CONFORMAL COATING COMPOUNDS

CONTRACT NAS 9-11068

VOLUME II

TABLES

(31 Jun 1974)

Sheldon L. Lieberman

REPRODUCED BY  
NATIONAL TECHNICAL  
INFORMATION SERVICE  
U.S. DEPARTMENT OF COMMERCE  
SPRINGFIELD, VA. 22161

Furane Plastics, Inc.  
5121 San Fernando Rd. W.  
Los Angeles, CA 90039

# N O T I C E

THIS DOCUMENT HAS BEEN REPRODUCED FROM THE  
BEST COPY FURNISHED US BY THE SPONSORING  
AGENCY. ALTHOUGH IT IS RECOGNIZED THAT CER-  
TAIN PORTIONS ARE ILLEGIBLE, IT IS BEING RE-  
LEASED IN THE INTEREST OF MAKING AVAILABLE  
AS MUCH INFORMATION AS POSSIBLE.

## LIST OF TABLES

<u>Table</u>		<u>Page</u>
3-1	Material Properties: Prior Contractual Efforts	II-1
3-2	Probability of Success Analysis: Prior Contractual Efforts	II-2
3-3	Elemental Analysis	II-3
6-1	Silicone RTV's (NASA-MSC-SG-12 KI Modifications): Formulations	II-4
6-2	Material Sources	II-5
6-3	Silicone RTV's (NASA-MSC-SG-12 KI Modification): Formulation Processing	II-8
6-4	Silicone RTV's (NASA-MSC-SG-12 KI Modifications): Characteristics (Cured/Post Cured)	II-9
6-5	Silicone RTV's (NASA-MSC-SG-12 KI Modifications): Preliminary Flammability Test Conditions/Results	II-10
6-6	Silicone/Fluorosilicone RTV's (F-387 Modifications): Formulations	II-11
6-7	Silicone/Fluorosilicone RTV's (F-387 Modifications): Formulation Processing	II-12
6-8	Silicone/Fluorosilicone RTV's (F-387 Modifications): Characteristics (Cured/Post Cured)	II-13
6-9	Silicone/Fluorosilicone RTV's (F-387 Modifications): Preliminary Flammability Test Conditions/Results	II-14
6-10	Polyester Systems	II-16
6-11	Polyester Preblends: Formulations	II-17
6-12	Polyesters (Ketone Peroxide Cured): Formulations	II-18
6-13	Polyesters (Aromatic Diacyl Peroxide Cured): Formulations	II-19
6-14	Polyester Preblends: Formulation Processing	II-20
6-15	Polyesters: Formulation Processing	II-21

## LIST OF TABLES (cont)

<u>Table</u>	<u>Page</u>
6-16 Polyester Preblends: Characteristics	II-22
6-17 Polyesters: Characteristics	II-23
6-18 Polyesters (Alkyl Peroxyester Cured): Formulations	II-25
6-19 Polyesters (Phase II): Characteristics	II-26
6-20 Polyesters (Phase III): Formulations	II-27
6-21 Polyesters (Phase III): Formulation Processing	II-28
6-22 Polyesters (Phase III): Characteristics	II-29
6-23 Potential Epoxy Materials	II-30
6-24 Epoxy Preblends: Formulations	II-31
6-25 Epoxy Preblends: Formulation Processing	II-32
6-26 Epoxy Preblends: Characteristics (Precured)	II-33
6-27 Epoxy Preblends: Characteristics (Cured/Post Cured)	II-34
6-28 Epoxies: Formulations	II-35
6-29 Epoxies: Characteristics (Precured)	II-36
6-30 Epoxies: Formulation Processing	II-37
6-31 Epoxies: Characteristics (Cured/Post Cured)	II-38
6-32 Epoxy Properties Comparison	II-39
6-33 Epoxies (Test Specimens): Formulations	II-40
6-34 Epoxies (Test Specimens): Formulation Processing	II-41
6-35 Epoxies: Preliminary Flammability Test Conditions/Results	II-42
6-36 Urethane Candidate Materials (Literature Data)	II-43
6-37 Urethane Candidate Materials: Weight Comparison with Brominex 160 P	II-44

## LIST OF TABLES (cont)

<u>Table</u>	<u>Page</u>
6-38 Urethane Candidate Materials: Preblend Equivalents Comparison with Brominex 160 P	II-45
6-39 Urethane Candidate Materials: Formulation Comparison with Brominex 160 P	II-47
6-40 Urethanes (Phase I): Formulations	II-49
6-41 Urethane Candidate Materials (Lot Data)	II-51
6-42 Urethanes (Phase I): Formulation Processing	II-52
6-43 Urethanes (Phase I): Characteristics	II-55
6-44 Urethanes (Phase II): Formulations	II-59
6-45 Urethanes (Phase II): Formulation Processing	II-60
6-46 Urethanes: Preliminary Flammability Test Conditions/Results	II-61
6-47 Epoxy-Urethanes (Pre-Reacted Urethane): Formulations	II-62
6-48 Epoxy-Urethanes (Pre-Reacted Urethane): Formulation Processing	II-63
6-49 Epoxy-Urethanes (Pre-Reacted Urethane) Characteristics	II-64
6-50 Epoxy-Urethanes (Co-Reacted): Formulations	II-65
6-51 Epoxy-Urethanes Elemental Analysis: Unmodified (I-143L)	II-66
6-52 Epoxy-Urethanes (Co-Reacted): Formulation Processing	II-67
6-53 Epoxy-Urethanes (Co-Reacted): Characteristics	II-69
6-54 Epoxy-Urethanes Elemental Analysis: Vircol 82 Modified	II-71
6-55 Epoxy-Urethanes Elemental Analysis: Unmodified (PAPI 901)	II-72
6-56 Epoxy-Urethanes: Preliminary Flammability Test Conditions/Results	II-73
6-57 Electrical Resistance (Qualitative)	II-74

## LIST OF TABLES (cont)

<u>Table</u>		<u>Page</u>
6-58	Electrical Resistance Tests: Qualitative <u>vs.</u> Quantitative	II-75
6-59	Epoxy-Urethanes: Evaluation of Process Variables and Anti-Foaming Agents	II-76
6-60	Evaluation of Contamination by Anti-Foaming Agents	II-77
7-1	Final Screening/Product Characterization: Formulations	II-78
7-2	Final Screening/Product Characterization: Formulation Processing	II-79
7-3	Final Screening/Product Characterization: Specimen Distribution	II-81
7-4	Formulation Properties: Modified Silicone RTV	II-85
7-5	Formulation Properties: Modified Fluorosilicone RTV	II-86
7-6	Formulation Properties: Epoxy	II-87
7-7	Formulation Properties: Epoxy-Urethane	II-88
7-8	Hardness	II-89
7-9	Viscosity	II-90
7-10	Formulations Properties: Summary	II-91
7-11	Formulations Properties: Comparison With Previous R & D Efforts (Silicone RTV Based)	II-92
7-12	Formulations Properties: Comparison With Previous R & D Efforts (Fluorosilicone RTV Based)	II-93
7-13	Final Screening Flammability Test: Conditions/Results	II-94
8-1	Carbon Monoxide (CO) and Total Organics (TO)	II-95
8-2	Odor	II-96
8-3	Vacuum Effects: Silicone RTV	II-97

## LIST OF TABLES (cont)

<u>Table</u>		<u>Page</u>
8-4	Vacuum Effects: Epoxy-Urethane	II-98
8-5	Vacuum Effects: Epoxy (600-1-4B)	II-99
8-6	Vacuum Effects: Epoxy (600-1-1)	II-100
8-7	Vacuum Effects: Summary	II-101
8-8	Tensile Strength/Elongation After Oxygen Aging	II-102
8-9	Oxygen Impact	II-103
9-1	Modified Silicone RTV: Production Formulations	II-104
9-2	Viscosity of EPOCAST 87517-A/B	II-105

TABLE 3-1  
MATERIAL PROPERTIES: PRIOR CONTRACTUAL EFFORTS

Property	T/M (9)	Compound Requirement	No. (9)	NASA - MSC - SG-12KI (Ref. 3-7)			NAS9-8750 (Ref. 3-7)			NAS 9-8749 (Ref. 3-8)			Conformal Ctg. MRTA-5		
				min. max. ave.			min. max. ave.			min. max. ave.			min. max. ave.		
				min. max. ave.			min. max. ave.			min. max. ave.			min. max. ave.		
Dielectric Constant	M	5.0, max.	3	6.6	6.7	6.7	4.7	4.8	4.7	1.38	1.50	1.43	1.92	2.01	1.97
Power Factor	M	0.09, max.	3	0.003	0.008	0.005	0.020	0.021	0.020	0.017	0.022	0.020	0.048	0.051	0.050
Dielectric Strength (v/mil) (1)	M	350., min.	5	260.	310.	290.	340.	390.	370.	100.	160.	116.	20.	20.	20.
Volume Resistivity (ambient) (x10 <sup>14</sup> ohms-cm)	M	(P) 1., min. (C) 1., min.	3	0.062	0.55	0.30	19.	30.	24.	1.64	4.78	2.74	0.0867	0.0951	0.0899
Surface Resistivity (x10 <sup>12</sup> ohms)	M	1., min.	3	5.	22.	15.	230.	720.	390.	0.385	3.81	1.53	0.0811	0.145	0.105
Arc Resistance (seconds)	T	45., min. (2)	3	122.	124.	121.	6.	6.	6.	122.	124.	123.	129.	133.	130.
Insulation Resistance (megohms) ambient (x10 <sup>9</sup> )	M	1., min. (3)	3	21.	660.	330.	9.4	46.0	26.5	2.2	8.3	5.0	0.28	1.01	0.65
212°F		750., min.	3	48.x10 <sup>5</sup>	59.x10 <sup>5</sup>	60.x10 <sup>5</sup>	3800.	8000.	5900.	3.5	2100.	724.	67.	147.	115.
m.c. (4)/ambient		200., min.	3	1.9	27.	13.	7.9x10 <sup>4</sup>	9.6x10 <sup>4</sup>	8.8x10 <sup>4</sup>	81.	780.	360.	0.20	0.41	0.28
m.c. (4)/212°F		200., min.	3	0.44	0.78	0.65	860.	1130.	980.	no data	no data	no data	no data	no data	no data
vac. (5)/m.c. (4)/ambient		200., min.	1	0.037	1.8	0.76	—	—	10.6x10 <sup>4</sup>	3.6	7.8	5.5	<1.	<1.	<1.
vac. (5)/m.c. (4)/212°F		200., min.	1	0.01	0.23	0.10	—	—	960.	1.3	3.7	2.2	<1.	<1.	<1.
spid./m.c. (4)/ambient		200., min.	3	0.095	0.39	0.23	7.7x10 <sup>4</sup>	8.2x10 <sup>4</sup>	8.0x10 <sup>4</sup>	0.46	87.	30.6	0.10	0.14	0.12
spid./m.c. (4)/212°F		200., min.	3	0.025	0.057	0.039	870.	860.	870.	1.3	25.	14.1	0.15	0.20	0.17
Tear Strength (lb/in)	M	15., min.	5	32.	37.	36.	11.	14.	13.	no data	no data	no data	no data	no data	no data
25., min.	T	350., min.	5	250.	260.	260.	84.	98.	90.	70.9	90.0	81.6	brittle	2647.	4157.
Tensile Strength (psi)	T	125., min.	5	310.	330.	318.	120.	140.	130.	no data	no data	no data	no data	no data	no data
Elongation (%)	T	3., max. (opaque) 3., max. (clear)	3	—	—	nil	—	—	<1.	—	—	7.3	—	—	9.3
Shrinkage (%)	M	30-85. (Shore A)	5	64.	68.	66.	60.	68.	65.	79.	84.	—	—	—	—
Hardness (after full cure)	M	Water clear	—	o p a q u e	o p a q u e	o p a q u e	o p a q u e	o p a q u e	o p a q u e	(30.'D') (35.'D')	(30.'D') (35.'D')	—	—	—	—
Clarity	T	100. to 6,000.	—	—	—	2240.	52.8	56.5	—	—	—	45.	15.	20.	—
Viscosity, 77°F (poises)	T	1.25, max.	3	1.55	1.61	1.50	1.65	1.69	1.67	—	—	0.36	—	—	0.81
Specific Gravity	T														

NOTES:

- 50 mils thick.
- Based on average value out of 5 for each specimen.
- Based on average value out of 4 for each specimen.
- Moisture cycle (m.c.): 75-160°F/95% R.H./1 day per cycle/5 days.
- Vacuum (vac): 1 x 10<sup>-4</sup> torr/ambient temp./24 hrs.

- With 3 equal coats of "SC" (Dow Chemical Company)
- Vacuum (vac): 1 x 10<sup>-4</sup> torr/250°F/24 hrs., then 212°F.
- Number of individually fabricated specimens.
- T.....Target Value M.....Mandatory Value



TABLE 3-2

## PROBABILITY OF SUCCESS ANALYSIS(1): PRIOR CONTRACTUAL EFFORTS

Property	Compound Requirement	SG-12 KI		F-387		1015		QC-15		MRTA-5	
		M(2)	T(3)	M	T	M	T	M	T	M	T
Dielectric Constant	5.0, max.	NG	-	S	-	E	-	E	-	S	-
Power Factor	0.09, max.	E	-	S	-	S	-	S	-	E	-
Dielectric Strength (v/mil) (4)	350., min.	NG	-	S?	-	NG?	-	ING	-	S	-
Volume Resistivity (ambient) (x10 <sup>12</sup> ohms-cm)	(P) 1., min. (C) 1., min.	NG	-	S	-	S	-	ING	-	E	-
Surface Resistivity (x10 <sup>12</sup> ohms)	1., min.	S	-	E	-	S?	-	ING	-	E	-
Arc Resistance (seconds)	45., min.	-	E	-	ING	-	E	-	E	-	E
Insulation Resistance (megohms)											
ambient (x10 <sup>3</sup> )	1., min.	E	-	E	-	S	-	NG	-	E	-
212°F	750., min.	E	-	E	-	NG	-	ING	-	E	-
m.c. (5)/ambient	200., min.	ING	-	E	-	S?	-	ING	-	S?	-
m.c. (5)/212°F	200., min.	ING	-	S	-	?	-	?	-	S?	-
vac./ambient	200., min.	ING(6)	-	E(6)	-	ING(7)	-	ING(7)	-	ING(7)	-
vac./212°F	200., min.	ING(6)	-	S(6)	-	ING(7)	-	ING(7)	-	ING(7)	-
rprd./m.c. (4)/amb.	200., min.	ING	-	E	-	ING?	-	ING	-	?	-
rprd./m.c. (4)/212°F	200., min.	ING	-	S	-	ING?	-	ING	-	?	-
Tear Strength (lb./in)	15., min. 25., min.	S	-	NG	-	?	-	?	-	?	-
Tensile Strength (psi)	350., min.	-	NG	-	ING	-	ING	-	ING	-	E
Elongation (%)	125., min.	-	E	-	S?	-	?	-	(ING)?	-	ING
Shrinkage (%)	1., max. (opaque) 3., max. (clear)	S	-	S	-	ING	-	ING	-	ING	-
Hardness (after full cure)	30-85. (Shore A)	S	-	S	-	S	-	ING	-	NG	-
Clarity	Water Clear	-	ING	-	ING	-	ING	-	ING	-	ING
Viscosity, 77°F (poises)	100. to 6,000.	-	S	-	NG?	-	NG?	-	NG?	-	E
Specific Gravity	1.25, max.	-	ING	-	ING	-	E	-	E	-	ING

## NOTES:

1. E ----- Excellent  
S ----- Satisfactory  
NG ----- No Good  
ING ----- Irremediably No Good
2. M ----- Mandatory Value
3. T ----- Target Value

4. 50 mils thick.
5. Moisture cycle (m.c.): 75-160°F/95% R.H./1 day per cycle/5 days.
6. Vacuum (vac): 1. x 10<sup>-4</sup> torr/ambient temp./24 hours.
7. Vacuum (vac): 1. x 10<sup>-4</sup> torr/250°F/24 hrs., then 212°F.

TABLE 3-3  
ELEMENTAL ANALYSIS

Compound	Constituents, approx. (%)						
	C	H	O	Si	F	Br	P
dimethyl silicone RTV (e.g. Dow Corning's Sylgards)	32.5	8.1	21.6	37.9	---	---	---
fluorinated silicone RTV (e.g. unfilled version of Dow Corning's 77-033)	30.8	4.5	10.3	17.9	36.6	---	---
BUSORB 34	54.6	6.7	28.0	---	---	---	10.8
methyl methacrylate polymer	60.0	8.0	32.0	---	---	---	---
dibromobutenediol (DBBD)	19.7	1.64 (1)	13.1	---	---	65.7	---

(1) After loss of hydrogen from both hydroxyl groups (i.e. after condensation reaction).

TABLE 6-1

## SILICONE RTV'S

(NASA-MSC-SG-12KI MODIFICATIONS)

Formulations (phr)

Component	S	475	476	477	478	479	480	481	387
Sylgard 186	1	100.	100.	100.	100.	100.	100.	100.	
Phos-Chek P/30	2	75.	50.	25.	25.				
7570 glass frit (1)	3	50.	25.	25.		25.			
Dechlorane 604	4						25.		150.
RTV 77-033	5								100.
Sylgard 186 Catalyst	1	10.	10.	10.	10.	10.	10.	10.	
RTV 77-033 Catalyst	5								10.

S ..... Source (See Table 6-2)

1. 325 mesh, predried 16 hrs./212°F

TABLE 6-2  
MATERIAL SOURCES

<u>S-</u>	<u>Source</u>	<u>Description</u>
1.	Dow Corning	silicone RTV
2.	Monsanto, Inorganic Chem. Div.	ammonium polyphosphate
3.	Corning Glass	high lead glass
4.	Hooker, Industrial Chem. Div.	chlorine/bromine organic compound
5.	Dow Corning	fluorosilicone RTV
6.	Furane Plastics, Inc.	in-house compounding
7.	Diamond Shamrock Chem. Co. Resinous Chem. Div.	brominated polyester
8.	" " " "	bisphenol polyester
9.	White Chemical Corp.	---
10.	Diamond Shamrock Chem. Co. Resinous Chem. Div.	isophthalic flexible polyester
11.	" " " "	bisphenol flexible polyester
12.	Stauffer Chemical Co., Specialty Chem. Div.	reactive chlorinated phosphorous monomer
13.	Weston Chemical Inc.	reactive fire retardant monomer
14.	White Chemical Corp.	" " " "
15.	Chemetron Noury Corp.	free radical catalysts
16.	Wallace & Tiernan, Inc. Lucidol Div.	free radical catalysts
17.	The Norac Co., Inc.	60% MEK peroxide in dimethyl phthalate

TABLE 6-2 (cont)  
MATERIAL SOURCES

<u>S-</u>	<u>Source</u>	<u>Description</u>
18.	Cincinnati Milacron Co.	cobalt naphthanate (12% Co)
19.	Matheson Coleman & Bell	2,2'-(phenylimino)diethanol (or phenyl diethanolamine)
20.	Wallace & Tiernan, Inc., Lucidol Div.	5% t-butyl peroctoate in dioctyl phthalate
21.	Ciba Products Co.	Araldite DP-449
22.	Dow Chemical Co., Designed Products Dept.	---
23.	Shell Chem. Co., Polymers Div.	---
24.	General Electric Co., Silicone Div.	amine-cured silicone RTV
25.	Union Carbide Corp.	---
26.	Michigan Chemical Corp.	---
27.	" " "	tetrabromophthalic anhydride
28.	White Chemical Corp.	bis dibromopropanol phosphoryl dimethylol amide
29.	" " "	mono dibromopropanol maleate
30.	Union Carbide Corp.	diethylene triamine
31.	" " "	triethylene tetramine
32.	" " "	liquid polyamine
33.	Dow Chemical Co. Halogens Res. Lab.	dibromoneopentyl glycol
34.	G A F Corp.	---
35.	Mobile Chemical Co., Industrial Chem. Div.	phosphonate dihydroxy polyol

TABLE 6-2 (cont)

## MATERIAL SOURCES

<u>S-</u>	<u>Source</u>	<u>Description</u>
36.	Stauffer Chem. Co., Specialty Chem. Div.	diethyl N,N-bis(2-hydroxy ethyl) amino methyl phosphonate
37.	The Upjohn Co., Polymers Chem. Div.	phosphorus-containing polyol
38.	Swift Chemical Co.	bromine/phosphorus-containing dihydroxy polyol
39.	Swift Chemical Co.	tolylene diisocyanate (TDI) based, bromine-containing prepolymer in TDI
40.	The Upjohn Co., Polymers Chem. Div.	low viscosity version of diphenyl methane diisocyanate
41.	The Upjohn Co., Polymers Chem. Div.	modified polymethylene polyphenylisocyanate
42.	M&T Chemicals Inc.	stannous octoate
43.	M&T Chemicals Inc.	dibutyl tin dilaurate
44.	Dow Chemical Co., Designed Products Dept.	urethane modified epoxy
45.	Union Carbide Co.	dimethylaminopropyl amine
46.	Stauffer Chem. Co.	diethyl N,N-bis(2-hydroxy ethyl) amino methyl phosphonate

TABLE 6-3  
SILICONE RTV'S  
(NASA-MSC-SG-12KI MODIFICATIONS)  
- FORMULATION PROCESSING -

Formulation No. F-	Cure (1)		Post Cure	
	Time (hrs/min)	Temp. (°F)	Time (hrs/min)	Temp. (°F)
475-1	2./-	150.	51./50	100.
476-1	2./15	150.	51./50	100.
477-1	2./30	150.	51./50	100.
478-1	2./-	150.	51./50	100.
479-1	2./-	150.	50./45	100.
480-1	3./-	150.	49./30	100.
481-1	2./-	150.	54./15	100.

1. Time in mold

TABLE 6-4

## SILICONE RTV'S

(NASA-MSC-SG-12KI MODIFICATIONS)

## CHARACTERISTICS

## CURED/POST CURED

Properties	Formulations						
	475	476	477	478	479	480	481
Cured	Y	Y	Y	Y	Y	Y	Y
Tacky	N	N	N	N	VS	N	N
Flexible	Y	Y	Y	Y	Y	Y	Y
Memory	Y	Y	Y	Y	Y	Y	Y
Cohesion	X	X	X	X	X	X	X
Tear Resistance	X	F	F	F	X	X	X
Crack Resistance (1)	X	X	X	X	X	X	X
Crack Propagation (1)	X	X	X	X	X	X	X
Porous	S	N	N	N	N	S	N
Adheres to unclean alum. foil cup	--	VS	VS	VS	VS	S	N
Cheesy	N	N	N	N	N	N	N
Hardness (Durometer A)	65.	62.	55.	52.	50.	44.	45.
Specific gravity	1.56	1.40	1.38	1.24	1.32	1.27	---

Y ..... Yes

N ..... No

F ..... Fair

X ..... Satisfactory

S ..... Slightly

VS ..... Very Slight

1. 180° bend (face-to-face contact)



TABLE 6-5  
SILICONE RTV'S  
(NASA-MSC-SG-12K1 MODIFICATIONS)  
PRELIMINARY FLAMMABILITY  
-TEST CONDITIONS/RESULTS-

		Specimen															
		475- 1A-1	475- 1A-2	476- 1A-1	476- 1A-2	477- 1A-1	477- 1A-2	478- 1A-1	478- 1A-2	479- 1A-1	479- 1A-2	480- 1A-1	480- 1A-2	481- 1A-1	481- 1A-2	481- 1A-3	481- 1A-4
O <sub>2</sub> pressure (psia)		3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	6.00	3.00
N <sub>2</sub> pressure (psia)		7.00	7.00	7.00	7.00	7.00	7.00	7.00	7.00	7.00	7.00	7.00	7.00	7.00	7.00	4.00	7.00
Specimen length (in)		5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
Specimen thick. (in)		0.079	0.078	0.078	0.078	0.078	0.078	0.075	0.075	0.076	0.076	0.075	0.075	0.079	0.077	0.077	0.078
Ignition time (sec)		30.	30.	30.	30.	30.	30.	30.	30.	30.	30.	30.	30.	30.	30.	30.	30.
R	Burn time (sec)	30.	30.	30.	30.	47.	50.	48.	50.	90.	110.	35.	30.	75.	72.	95.	90.
	flame-out glow-out	0	0	0	0	0	0	0	0	30.	0	0	0	0	0	0	0
Flame color		yellow	yellow	yellow	yellow	yellow	yellow	yellow	yellow	yellow	yellow	yellow	yellow	yellow	yellow	yellow	yellow
E	Smoke	wht/bk	wht/blk	black	black	white	white	white	white	blk/wht	blk/wht	blk/wht	blk/wht	black	black	black	black
	amount (1)	S	S	S	S	P	P	P	P	S	S	S	S	S	S	P	S
Sparkling (1)		N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Sputtering (1)		N	N	N	N	N	N	N	N	N	N	N	N-5	N	N	N	N
Dripping flaming particles (1)		N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Configuration (2)		Y	Y	Y	Y	Y	Y	(6)	(6)	Y	Y	Y	Y	Y	Y	N	Y
Residue (3) (%)		85.	88.	87.	85.	78.	70.	68.	66.	85.	81.	91.	96.	88.	73.	15.	78.
Melted (1)		N	N	N	N	N	N	N	N	N	N	N	N	N	N	S	N
S	Color in exterior	white	white	white	white	white	white	white	white	white	blk/wht	black	black	white	white	white	white
	burn area interior	"	"	"	"	"	"	"	"	"	"	"	"	"	"	grey	"
	Texture in powdery	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
	burn area crusty	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Conclusion (5)		SE	SE	SE	SE	SE	SE	SE	SE	SE	SE	SE	SE	SE	SE	SE	SE
		1.2	1.15	1.15	1.25	3.75	4.0	4.2	4.9	1.4	1.7	3.2	3.3	1.5	1.75	5.0+	1.4

1. N.....None S.....Some P.....Profuse

2. Generally similar to original specimen: Yes or No.

3. Amount left in (2).

4. Y.....Yes N.....No

5. NC.....Non combustible SE.....Self-extinguishing in XX inches NSE.....Non Self-extinguishing XX

6. Approx. 50%.

TABLE 6-6  
SILICONE / FLUROSILICONE RTV'S  
(F-387 MODIFICATIONS)

Formulations (phr)

Component	S	461-4	387-20	461-5	387-21	473	470	472	471	468	467	474
RTV 77-033	5	100.		100.		100.						50.
RTV 94-531	5						100.	100.	100.			
Sylgard 186	1									100.	100.	50.
F-461-4	6		250.									
F-461-5	6				250.							
Dechlorane 604	4	150.		150.		75.		75.	150.	75.	150.	75.
RTV 77-033 Catalyst	5		10.		10.	10.						5.
RTV 94-531 Catalyst	5						10.	10.	10.			
Sylgard 186 Catalyst	1									10.	10.	5.

S ..... Source (See Table 6-2).

TABLE 6-7  
SILICONE / FLUROSILICONE RTV'S  
(F-387 MODIFICATIONS)  
- FORMULATION PROCESSING -

Formulation No. F-	Cure (1)		Post Cure		Total Time (hrs/min)
	Time (hrs/min)	Temp. (°F)	Time (hrs/min)	Temp. (°F)	
387-20	15./-	150.	---	---	15./-
387-21	15./-	150.	---	---	15./-
473-1	16./20	150.	---	---	16./20
470-1	2./15	150.	12./55	150.	15./10
472-1	3./55	150.	12./20	150.	16./15
471-1	3./30	150.	12./20	150.	15./50
469-1	4./-	150.	12./20	150.	16./20
467-1	2./-	150.	13./-	150.	15./-
474-1	7./30	150.	8./42	150.	16./12

1. Time in mold

TABLE 6-8

## SILICONE / FLUOROSILICONE RTV'S

(F-387 MODIFICATIONS)  
CHARACTERISTICS

## CURED/POST CURED

Properties	Formulations								
	387-20	387-21	473	470	472	471	468	467	474
Cured	(Y)		Y	Y	Y	Y	Y	Y	Y
Tacky	(VS)		N	N	N	N	N	N	N
Flexible	(Y)		Y	Y	Y	Y	Y	Y	Y
Memory	(Y)		SD	Y	SD	SD	SD	SD	Y
Cohesion	(P)		NG	NG	NG	NG	X	F	F
Tear Resistance	(P)		NG	NG	NG	NG	X	X	NG
Crack Resistance (1)	(X)		X	X	X	X	X	X	X
Crack Propagation (1)	(X)		X	NG	NG	NG	X	X	X
Porous	(X)		VS	VS	VS	N	VS	N	N
Adheres to unclean alum. foil cup	(N)		--	--	--	--	--	--	--
Cheesy	(N)		N	N	N	N	N	N	N
Hardness (Durometer A)	65.	65.	59.	47.	66.	76.	49.	55.	42.
Specific gravity	1.82	1.82	1.67	1.41	1.65	1.79	1.42	1.60	1.52

1. 180° bend (face-to-face contact)

Y ..... Yes

N ..... No

F ..... Fair

P ..... Poor

SD ..... Slight Deformation

NG .... Not Good

VS ..... Very Slight

( ) ..... F-387-2, Table 6-85, Ref. 3-7.

TABLE 6-9  
SILICONE/FLUOROSILICONE RTV'S  
(F-387 MODIFICATIONS)  
PRELIMINARY FLAMMABILITY  
-TEST CONDITIONS/RESULTS-

		Specimen									
		387- 20A-1	387- 20A-2	387- 20A-3	387- 20A-4	387- 21C-1	387- 21D-1	387- 21D-2	387- 21D-3	473- 1A-1	473- 1A-2
R E S U L T S  11-14	O <sub>2</sub> pressure (psia)	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00
	N <sub>2</sub> pressure (psia)	7.00	7.00	7.00	7.00	7.00	7.00	7.00	7.00	7.00	7.00
	Specimen length (in)	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
	Specimen thick. (in)	0.059	0.054	0.055	0.060	0.094	0.124	0.125	0.124	0.075	0.076
	Ignition time (sec)	35.	30.	30.	30.	30.	30.	30.	30.	30.	30.
	Burn time   flame-out (sec)   glow-out	53. 0	45. 5.	32. 8.	37. 1.	43. 2.	36. 0	30. 0	35. 0	51. 0	60. 0
	Flame color	yellow	yellow	yellow	yellow	yellow	yellow	yellow	yellow	yellow	yellow
	Smoke   color   amount (1)	black P	black P	black P	black P	black P	black P	black S	black P	black P	black P
	Sparkling (1)	N	N	N	N	N	N	N	N	N	N
	Sputtering (1)	N-S	N-S	N-S	N-S	N-S	N-S	N-S	N-S	N-S	N-S
	Dripping flaming particles (1)	N	N	N	N	N	N	N	N	N	N
	Configuration (2)	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
	Residue (3) (%)	90.	96.	98.	98.	99.	99.+	99.+	99.+	92.	92.
	Melted (1)	N	N	N	N	N	N	N	N	N	N
	Color in   exterior burn area   interior	black "	black "	black "	black "	black "	black "	black "	black "	black "	black "
	Texture in   powdery burn area (4)   crusty	Y Y	Y Y	Y Y	Y Y	Y Y	Y Y	Y Y	Y Y	Y Y	Y Y
	Conclusion (5)	SE 1.2	SE 1.35	SE 1.1	SE 1.1	SE 0.6	SE 0.4	SE 0.8	SE 0.7	SE 1.75	SE 1.7

1. N.....None      S.....Some      P.....Profuse

2. Generally similar to original specimen: Yes or No.

3. Amount left in (2).

4. Y.....Yes      N.....No

5. NC.....Non combustible      SE.....Self-extinguishing in XX Inches      NSE.....Non Self-extinguishing  
XX

TABLE 6-9 (cont)  
SILICONE/FLUOROSILICONE RTV'S  
(F-387 MODIFICATIONS)  
PRELIMINARY FLAMMABILITY  
-TEST CONDITIONS/RESULTS-

		Specimen											
		470- 1B-1	470- 1B-2	472- 1A-1	472- 1A-2	471- 1B-1	471- 1B-2	468- 1A-1	468- 1A-2	467- 1A-1	467- 1A-2	474- 1A-1	474- 1A-2
O <sub>2</sub> pressure (psia)		3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00
N <sub>2</sub> pressure (psia)		7.00	7.00	7.00	7.00	7.00	7.00	7.00	7.00	7.00	7.00	7.00	7.00
Specimen length (in)		5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
Specimen thick. (in)		0.101	0.101	0.078	0.079	0.080	0.080	0.104	0.105	0.105	0.105	0.089	0.088
Ignition time (sec)		30.	30.	30.	30.	30.	30.	30.	30.	30.	30.	30.	30.
II-15	R	Burn time (sec)	83.	88.	65.	74.	35.	35.	30.	35.	35.	30.	34.
		flame-out glow-out	0	0	0	0	0	0	0	0	0	0	0
	E	Flame color	yellow	yellow	yellow	yellow	yellow	yellow	yellow	yellow	yellow	yellow	yellow
		Smoke color	black	black	black	black	black	black	black	black	black	black	black
		amount (1)	P	P	P	P	P	P	S	S	S	P	P
	S	Sparking (1)	N	N	N	N	N	N	N	N	N	N	N
		Sputtering (1)	N	N	N-S	N-S	N-S	N-S	N-S	N-S	N-S	N-S	N-S
	U	Dripping flaming particles (1)	N	N	N	N	N	N	N	N	N	N	N
	L	Configuration (2)	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
		Residue (3) (%)	97.	97.	95.	93.	95.	97.	99.+	99.	98.	96.	93.
	T	Melted (1)	N	N	N	N	N	N	N	N	N	N	N
		Color in exterior burn area	white	white	white	black	black	black	black	black	black	black	black
	S	interior	wt/blk	wt/blk	black	"	"	"	"	"	"	"	"
		Texture in burn area (4)	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
		powdery crusty	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Conclusion (5)		SE	SE	SE	SE	SE	SE	SE	SE	SE	SE	SE	SE
		2.2	2.2	1.6	1.75	0.95	0.8	1.45	1.2	1.5	1.55	2.2	2.0

1. N.....None      S.....Some      P.....Profuse

2. Generally similar to original specimen: Yes or No.

3. Amount left in (2).

4. Y.....Yes      N.....No

5. NC.....Non combustible      SE.....Self-extinguishing in XX inches      NSE.....Non Self-extinguishing XX

TABLE 6-10  
POLYESTER (1) SYSTEMS

Function	Name	Description	S	Viscosity (cps)	C	Elemental Analysis (%)				
						H	O	Cl	Br	P
Base resins	DION FR-6430 DION COR-RES 6432 TEPH-AE	isophthallic polyester (bisphenol?) polyester tribromophenyl allyl ether	7	solid	?	?	?	--	31.	--
			8	solid	?	?	?	--	<31.	--
			9	solid	29.15	1.89	4.32	--	64.65	--
Flexible resins	DION-ISO 6481 DION COR-RES 6435	isophthallic polyester bisphenol polyester	10	high visc. liq.	?	?	?	--	--	--
			11	950 poise	?	?	?	--	--	--
Reactive diluent	FYROL Bis-Beta DMAP BIS(DEP)H —	bis (beta-chloroethyl vinyl phosphonate dimethyl allyl phosphonate bis (dibromopropanol) phosphonyl -2- oxyethyl methacrylate (styrene)	12	16.2 (25°C)	30.9	4.73	20.6	30.5	--	13.3
			13	watery liquid	40.0	7.34	32.0	--	--	20.65
			14	med. visc. liq.	23.6	3.12	15.76	--	52.5	5.08
			--	(watery liquid)	(92.31	7.69	--	--	--	-- )
Catalysts	CADOX TS-50 or LUPERCO CST CADOX MDP or LUPERCOL DDM CADOX BTP or LUPERCO ATC	2,4-Dichlorobenzoyl peroxide in silicone fluid 60% methyl ethyl ketone peroxide in dimethyl phthalate 50% benzoyl peroxide in tricresyl phosphate	15	paste						
			16							
			15	liquid						
			16							
			15	paste						
			16							

S.....Source (See Table 6-2)

1. No styrene present, except as noted.

11-11

TABLE 6-11

## POLYESTER PREBLEND

Formulations (pbw)

Component	S	482	483	484	485	486	487	488	489	490
Dion FR-6430	7	100.	100.	100.						
Dion-ISO 6481	10				75.	75.	75.			
Dion COR-RES 6435	11							75.	75.	75.
FYROL Bis-Beta	12		50.							
DMAP	13			50.						
BIS (DBP) H	14	50.								
482-1	6				150.			150.		
483-1	6					150.			150.	
484-1	6						150.			150.

S.....Source (See Table 6-2)



TABLE 6-12  
POLYESTERS  
- KETONE PEROXIDE CURED -

Component	S	Formulations (pbw)											
		491	492	493	494	495	496	509	510	511	503	504	505
Dion-ISO 6481	10							75.	50.	75.			
Dion FR-6430	7										100.	100.	100.
DMAP	13										50.	50.	25.
485-1	6	225.											
486-1	6		225.										
487-1	6			225.									
488-1	6				225.								
489-1	6					225.							
490-1	6						225.						
509-1											75.45		
510-1												50.8	
511-1													75.8
MEKP-5	17	2.25	2.25	2.25	2.25	2.25	2.25				2.25	2.	2.
ADVADRY 12% cobalt	18	0.90	0.90	0.90	0.90	0.90	0.90	0.45	0.8	0.8			

S.....Source (See Table 6-2)

TABLE 6-13

## POLYESTERS

- AROMATIC DIACYL PEROXIDE CURED -

Formulations (pbw)

Component	S	497	498	499	500	501	502
485-1	6	225.					
486-1	6		225.				
487-1	6			225.			
488-1	6				225.		
489-1	6					225.	
490-1	6						225.
T S -50	15	4.50	4.50	4.50	4.50	4.50	4.50
P D E A	19	1.	1.	1.	1.	1.	1.

S.....Source (See Table 6-2)

TABLE 6-14  
POLYESTER PREBLEND

- Formulation Processing -

Formulation No. F-	(1)		Steps (2)		(3)	
	(°F)	(min.)	(°F)	(min.)	(°F)	(min.)
482-1	250	5	---	---	---	---
483-1	"	"	---	---	---	---
484-1	200	"	---	---	---	---
485-1	---	---	200	5	---	---
486-1	---	---	150	5	---	---
487-1	---	---	" (4)	"	---	---
488-1	---	---	200	"	---	---
489-1	---	---	150	"	---	---
490-1	---	---	"	"	---	---
509-1	---	---	---	---	150	5
510-1	---	---	---	---	"	"
511-1	---	---	---	---	"	"

1. Blend flame retardant resin with reactive diluent at \_\_\_\_\_ °F for \_\_\_\_\_ minutes.  
Cool to room temperature.
2. Blend reactive flexibilizer with diluted resin at \_\_\_\_\_ °F for \_\_\_\_\_ minutes.  
Cool to room temperature.
3. Blend reactive flexibilizer with accelerator at \_\_\_\_\_ °F for \_\_\_\_\_ minutes.
4. Room temperature blending probably feasible.

TABLE 6-15

## POLYESTERS

- Formulation Processing -

Formulation No. F-	Steps							
	(1) (°F)	(1) (min.)	(2) (°F)	(2) (min.)	(3) (°F)	(3) (min.)	(4) (°F)	(4) (hrs.)
491-1	150	5	---	---	150/RT (6)	0.5/5	150	24
492-1	"	"	---	---	" /" (6)	" /2	"	"
493-1	" (5)	"	---	---	RT	2	"	"
494-1	"	"	---	---	150/RT (6)	0.5/4	"	"
495-1	"	"	---	---	" /" (6)	" /3	"	"
496-1	"	"	---	---	" /" (6)	" /2	"	"
497-1	"	"	---	---	" /" (6)	" /"	"	"
498-1	"	"	---	---	" /" (6)	" /2	"	"
499-1	" (5)	"	---	---	RT	4	"	"
500-1	"	"	---	---	150/RT (6)	" /2	"	"
501-1	"	"	---	---	" /" (6)	" /3	"	"
502-1	"	"	---	---	" /" (6)	" /2	"	"
503-1A	---	---	200	5	79	3	150	24
1B	---	---	"	"	"	"	"	48
504-1A	---	---	250	"	78	"	"	24
-1B	---	---	"	"	"	"	"	48
505-1A	---	---	275	"	77	"	"	24
-1B	---	---	"	"	"	"	"	48
506-1A	---	---	150-200	"	"	"	"	24
-1B	---	---	"	"	"	"	"	48
507-1A	---	---	250	"	"	"	"	24
-1B	---	---	"	"	"	"	"	48
508-1A	---	---	275	"	76	5	"	24
-1B	---	---	"	"	"	"	"	48

1. Blend accelerator (or promoter) with preblend at \_\_\_\_\_°F for \_\_\_\_\_ minutes. Cool to room temperature.
2. Blend flame retardant resin, preblend, and reactive diluent at \_\_\_\_\_°F for \_\_\_\_\_ minutes, and then blend before cool.
3. Add catalyst into preblend at \_\_\_\_\_°F for \_\_\_\_\_ minutes.
4. Cure at \_\_\_\_\_°F for \_\_\_\_\_ hours.
5. Room temperature blending probably feasible.
6. Formulation blended while dropping to room temperature.

TABLE 6-16

## POLYESTER PREBLEND

## - CHARACTERISTICS (1) -

Properties	Formulations								
	482	483	484	485	486	487	488	489	490
Homogenous	Y	Y	Y	Y	Y	Y	N	?	?
Lumps	N	N	N	N	N	N	N	N	N
Coarse Particles	N	N	N	N	N	N	N	N	N
Clear	Y	Y	Y	Y	Y	Y	Y	semi- opaque	semi- opaque
Color	very lt. grn.	very very lt. grn	(2)	lt.yell.	very very lt. yell.	very lt. yell	lt. yell.	lt. yell.	lt. yell.
Viscosity (RT)	semi- solid	med.	low med.	very high	high	med.	very high	med.	low med.

1. Qualitative.
2. Almost water white.

Y.....Yes  
N.....No

TABLE 6-17  
POLYESTERS  
- CHARACTERISTICS -

Properties (1)	Formulations											
	491	492	493	494	495	496	497	498	499	500	501	502
Homogenous (14)	Y	Y	Y	N	N	?	Y	Y	Y	?	N	Y
Lumps (14)	N	N	N	N	N	N	N	N	N	N	N	N
Coarse Particles (14)	N	N	N	N	N	N	N	N	N	N	N	N
Clear (14)	Y	Y	Y	N	Y	Y	S-O	Y	Y	N	Y	S-O
Color (14)	blue	blue	grey	blue	blue	grey	brn.	grey	grey	lt. yell.	blk.	dk. grn.
Viscosity (RT) (13)	very high	high	med.	very high	med.	low med.	very high	high	med.	(3)	med.	low med.
Pot Life (hrs.)	(4)	0	6	(6)	(8)	15 (10)	<5	(4)	(4)	(12)	(4)	(4)
Cured	(5)	(5)	Y	(7)	(9)	?	(11)	(11)	(11)	(5)	(11)	(11)
Tacky	S	Y	N	Y	---	Y	---	---	---	---	---	---
Flexible	---	---	Y	(7)	---	---	---	---	---	---	---	---
Memory	---	---	Y	---	---	---	---	---	---	---	---	---
Cohesion	---	---	P	---	---	---	---	---	---	---	---	---
Tear Resistance	---	---	P	---	---	---	---	---	---	---	---	---
Crack Resistance (2)	---	---	NG	---	---	---	---	---	---	---	---	---
Crack Propagation (2)	---	---	NG	---	---	---	---	---	---	---	---	---
Porous	---	---	Y	---	---	---	---	---	---	---	---	---
Cheesy	---	---	Y	---	---	Y	---	---	---	---	---	---

Y.....Yes  
N.....No

S-O.....Semi-Opaque

O.....None in 24 hrs.

S.....Slight

TABLE 6-17 (cont)

Notes

1. Qualitative evaluations.
2. 180° bend (face-to-face contact).
3. Increased rapidly (i.e., approximately 2 minutes) to a waxy state.
4. No gel in 48 hours.
5. Partial in 48 hours.
6. Separation into light grey and blue layers. Blue layer later much harder than grey layer.
7. Separation into 2 layers. Top layer: light grey, tacky surface, flexible, and cheesy. Bottom layer: blue and brittle.
8. Separated into purple and grey blotches. No gel.
9. Separation into blue and grey layers. No gel.
10. Room temperature specimen almost cured in 24 hours but had a tacky surface.
11. No cure in 48 hours.
12. Waxy in 5 hours.
13. Uncured state.

TABLE 6-18  
POLYESTERS  
- ALKYL PEROXYESTER CURED -

Component	S	Formulations (pbw)		
		506	507	508
DION FR-6430	7	100.	100.	100.
F-509-1 (1)	6	75.45		
F-510-1 (1)	6		50.8	
F-511-1 (1)	6			75.8
DMAP	13	50.	50.	25.
Lupersol PDO	20	2.25	2.	2.

S.....Source (See Table 6-2)

1. See Table 6-12.



TABLE 6-19

POLYESTERS  
(Phase II)

- Characteristics -

(Properties (1) (2))	Formulations											
	503		504		505		506		507		508	
	A	B	A	B	A	B	A	B	A	B	A	B
Homogenous (5)	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Lumps (5)	N	N	N	N	N	N	N	N	N	N	N	N
Coarse Particles (5)	N	N	N	N	N	N	N	N	N	N	N	N
Clear (5)	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Color (5)	blue	blue	blue	blue	blue	blue	blue	blue	blue	blue	blue	blue
Viscosity (RT) (5)	S.high med.	S.high med.	high med.	high med.	high	high	S.high med.	S.high med.	high med.	high med.	high	high
Cured	X	X	X	X	X	X	? (4)	? (4)	? (4)	? (4)	? (4)	? (4)
Tacky	N	N	N	N	N	N	T:N B:Y	T:N B:VS	T:N B:VS	T:N B:VS	T:N B:S	T:N B:S
Flexible	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Memory	Y	Y	Y	F	Y	Y	Y	Y	Y	Y	Y	Y
Cohesion	P	F	P	P	P	P	F	F	P	P	P	P
Tear Resistance	P	P	P	P	P	P	P	P	P	P	P	P
Crack Resistance (3)	NG	NG	NG	NG	NG	<NG	X	X	NG	NG	X	X
Crack Propagation (3)	NG	NG	NG	NG	NG	<NG	X	X	NG	NG	X	X
Porous	S	S	Y	Y	Y	Y	N	N	N	N	Y	Y
Adheres to unclean alum. foil cup	S	S	S	S	S	S	P	F	X	X	S	S
Cheesy	N	N	N	N	N	N	N	N	N	N	N	N

Y.....Yes  
N.....NoX.....Satisfactory  
F.....FairVS.....Very Slight  
S.....SlightP.....Poor  
NG.....Not GoodT.....Top (air exposed surface)  
B.....Bottom (non-exposed surface)

1. Qualitative.

2. All cured specimens were clear and  
had a bluish-green hue.

3. 180° bend (face-to-face contact).

4. Wrinkled top surface.

5. Uncured state.

TABLE 6-20

POLYESTERS  
(Phase III)

Component	S	Formulations (pbw)							
		493-2 (1)	503-2 (1)	(2)	549 (1)	(2)	550 (1)	(2)	
DION FR-6430	7	100.	100.	100.	100.	100.		100.	
DION-ISO 6481	10	75.		75.		75.		75.	
F-509-1 (3)	6		75.45		75.45				
F-487-1 (4)	6						225.		
DMAP	13	50.	50.	50.	50.	50.		50.	
MEKP-5	17	2.25	2.25	2.25					
TS-50	15				2.25	2.25	2.25	2.25	
AVADRY 12% Cobalt	18	0.9		0.45		0.45	0.9	0.9	

S.....Source (See Table 6-2)

1. As formulated.
2. Actual constituents.
3. See Table 6-12.
4. See Table 6-11.

TABLE 6-21

POLYESTERS  
(Phase III)  
- Formulation Processing -

Formulation No. F-	Steps							
	(1) (°F)	(min.)	(2) (°F)	(min.)	(3) (°F)	(hrs./min.)	(4) (°F)	(hrs./min.)
493-2A	200.	5.	77.	3.	R.T.	24.	---	---
-2B	"	"	"	"	"	"	150.	15 <sub>n</sub> /45.
503-2A	"	" (5)	78.	"	"	48.	---	---
-2B	"	" (5)	"	"	"	"	150.	24./15.
549-1A	"	" (5)	73.	"	"	12 days (6)	---	---
-1B	"	" (5)	"	"	"	" (6)	150.	4./-
550-1A	"	"	78.	"	"	13 days (6)	---	---
-1B	"	"	"	"	"	" (6)	150.	4./-

1. Preblend flame retardant resin, reactive flexibilizer, and reactive diluent at \_\_\_\_\_ °F. for \_\_\_\_\_ min. and cool. Add accelerator at room temperature and cool.
2. Add catalyst and blend at \_\_\_\_\_ °F for \_\_\_\_\_ minutes. Do not degas.
3. Cure at \_\_\_\_\_ °F for \_\_\_\_\_ hours/minutes.
4. Post cure at \_\_\_\_\_ °F for \_\_\_\_\_ hours/minutes.
5. Accelerator already preblended with reactive flexibilizer.
6. For gelation.

TABLE 6-22

POLYESTERS  
(Phase III)  
- Characteristics -

Properties (1)	493-2		503-2		549	550
	A	B	A	B		
Homogenous (2)	Y	Y	Y	Y	Y	Y
Lumps (2)	N	N	N	N	N	N
Coarse Particles (2)	N	N	N	N	N	N
Clear (2)	Y	Y	Y	Y	Y	Y
Color (2)	grey	grey	blue	blue	blue	purple
Viscosity (R.T.) (2)	med.	med.	s.high med.	s.high med.	s.high med.	med.
Cured	?	Y	?	Y	N (6)	?
Tacky	S	N	?	N	N	S
Flexible	Y	Y (4)	?	Y	Y	Y
Memory	Y	Y (4)	?	Y	Y	Y
Cohesion	NG	NG	?	NG	NG	NG
Tear Resistance	NG	NG	?	NG	NG	NG
Crack Resistance (3)	NG	NG	?	NG	X	X
Crack Propagation (3)	NG	NG	?	NG	X	X
Porous	N	N	?	N	N	N
Adheres to unclean alum. foil cup	---	---	---	---	---	---
Cheesy	Y	N	?	N	N	N
Color (5)	blue	blue	?	blue	blue	blue
Clear (5)	Y	Y	?	Y	(7)	(7)

Y.....Yes  
N.....No

X.....Satisfactory  
F.....Fair

VS.....Very Slight  
S.....Slight

P.....Poor  
NG.....Not Good

1. Qualitative.
2. Before Cure.
3. 180° bend (face-to-face contact).
4. Less than A.

5. After cure.
6. Inside.
7. Translucent.

TABLE 6-23

## POTENTIAL EPOXY MATERIALS

Function	Name	Description	S	Viscosity (cps)	E.E.W. (1)	Br (%)
Base resins	DP-449	epoxy	21	M.P. = 55°C	385	50
	D.E.N. 438	epoxy novalac	22	35,000-70,000	176-181	—
	D.E.R. 511	epoxy	22	A-D (2) (~50-100)	445-520	18-20
	D.E.R. 542	epoxy	22	solid	325-375	44-48
	D.E.R. 599	epoxy	22	250	300-350	50-54
	FRX-67	n,n-diglycidyl-2,4,6-tribromoaniline	23	(5)	240	51.5
Flexible resins	D.E.R. 732	polyglycol diepoxide	22	55-100	305-335	—
	D.E.R. 736	polyglycol diepoxide	22	30-60	175-205	—
	D.E.R. 741	?	22	2,500-4,500	364-380	—
	RTV 602 (4)	silicone	24	800-1,500	?	—
Catalysts	D.E.H. 61 (3)	amine	22	watery liquid	—	—
	DTA	diethylene triamine	25	watery liquid	—	—
	—	tetrabromomethylene dianiline	26	solid	—	62.4 (1.95%H)

S..... Source (See Table 6-2).

1. Epoxy equivalent weight.

2. Gardner-Holt

3. For D.E.R. 741

4. Amine cured.

5. 1900 cps (super cooled), melting point: 50.-55.°C.

11-30

TABLE 6-24

## EPOXY PREBLEND

Formulations (pbw)

Component	S	513	514	515	516	517	519	520	521	522	523	524	518	525	526	527	534	535	512
D.E.R., 741	22	100.			100.	100.			100.	100.			100.	100.	100.	100.		100.	
D.E.R., 732	22										100.	100.							
D.E.R., 542	22													100.					
DP-449	21														100.				
ERX-67	23															100.			
F-514-1	26				13.9														
F-515-1	36					15.9													
F-519-1	26								6.67			7.76							
F-520-1	26									7.18									
MAP	13																		100.
Firemaster PHT4	27																100.	31.15	
3is (DBP) AM	28																120.2		
DBP-ES	29																		210.67
D.E.H. 61	22	7.8	3.9	3.9			3.9	3.9											
DETA	30		10.				2.77				6.44								
TETA	31			12.				3.28											
ZZLA-0826	32												12.6						

S.....Source (See Table 6-2).

11  
65

TABLE 6-25

## EPOXY PREBLEND

- Formulation Processing -

Formulation No. F-	Steps (1)			
	(°F)	(min.)	(°F)	(hr./min.)
513-1A	69	3	150	4/0
-1B	69	3	"	24/0
514-1	69	2	---	---
515-1	68	2	---	---
516-1A	73	3	150	10/0
-1B	73	3	"	24/0
517-1A	73	3	"	10/0
-1B	73	3	"	24/0
519-1	70	3	---	---
520-1	70	3	---	---
521-1A	73	3	150	8/0
-1B	73	3	"	38/30
522-1A	74	2	"	8/0
-1B	74	2	"	38/30
523-1A	74	3	"	7/30
-1B	74	3	"	37/30
524-1A	73	2	"	7/0
-1B	73	2	"	37/30
518-1A	69	3	"	4/0
-1B	69	3	"	24/0
525-1	212	(4)	---	---
526-1	212	(4)	---	---
527-1	150	(4)	---	---
534-1	150-250	(5)	---	---
535-1	150-250	(6)	---	---
512-1	212	15	---	---

1. No degassing.

2. Blend at \_\_\_\_\_°F for \_\_\_\_\_ minutes.

3. Cure/post cure.

4. Continue heating until components are all liquid.

5. Continued until evident complete solution not possible below 250°F.

6. Polymerization appeared to take place before complete solution.

TABLE 6-26

## EPOXY PREBLEND

- Characteristics (Precured) -

## Formulations

Properties (1)	513	514	515	516	517	519	520	521	522	523	524	518	525	526	527	534	535
Homogenous	?	Y	Y	?	?	Y	Y	?	N	Y	Y	Y	N	N	Y	N	N
Lumps	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Coarse Particles	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Clear	T	Y	Y	T	T	Y	Y	T	opaque	Y	Y	Y	N (2)	N (2)	Y	N	N
Color	WW	Very lt. yell.	Very lt. yell.	WW	WW	Very lt. yell.	Very lt. yell.	WW	White	WW	WW	Very lt. yell.	(2)	(2)	Or. yell.	White	White
Viscosity (RT)	med.	watery	watery	low	low	watery	watery	low	low	almost watery	almost watery	low	(2)	(2)	slightly higher than low	med.	med.

1. Qualitative.  
2. Supersaturated solution.

Y.....Yes  
N.....No  
T.....Translucent  
WW.....Water White



TABLE 6-27

## EPOXY PREBLEND

- Characteristics (Cured/Post Cured) -

## Formulations

Properties (1)	513		516		517		521		522		523		524		518	
	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B
Cured	?	?	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Tacky	Y	Y	VS	VS	VS	N	N	N	N	N	N	N	VS (3)	N	N	N
Flexible	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Memory	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Cohesion		P	P	P	P	P	P	P	P	P	NG	NG	NG	NG	P	P
Tear Resistance		P	P	F	P	P	P	P	P	P	NG	NG	NG	NG	P	P
Crack Resistance (2)		X	X	X	X	X	X	X	X	X	NG	NG	NG	NG	NG	NG
Crack Propagation (2)		X	X	X	F	P	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG
Porous		N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Adheres to unclean alum. foil cup	F	F	S	S	S	F	S	F	F	F	N	N	N	N	S	VS
Cheesy		N	N	N	N	N	N	N	N	N	Y	Y	Y	S	N	S
Clear	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Color	lt. yell.	lt. yell.	lt. yell.	lt. yell.	lt. yell.	lt. yell.	lt. yell.	lt. yell.	lt. yell.	lt. yell.	WW	WW	WW	WW	lt. yell.	lt. yell.
Y.....Yes N.....No	X.....Satisfactory F.....Fair		VS.....Very Slight S.....Slight		P.....Poor NG.....Not Good		WW.....Water White									

1. Qualitative

2. 180° bend (face-to-face contact)

3. On exposed face.

TABLE 6-28

## EPOXIES

Formulations (pbw)

Component	S	528	529	530	531	532	533	536	537
F-525-1	6	200.							
F-526-1	6		200.						
F-527-1	6			200.		200.			
ERX-67	23				75.		75.	75.	75.
D.E.R. 741	22				100.		100.	100.	100.
RTV-602	24					25.			
F-519-1	6	13.34	13.34	13.34		13.34			
D.E.H. 61	22				7.8		19.04	17.92	16.79
DETA	30	0.35		3.04	6.44	3.04		0.64	1.29

S.....Source (See Table 6-2).

TABLE 6-29

## EPOXIES

- Characteristics (Precured) -

## Formulations

Properties (1)	528	529	530	531	532	533	536	537
Homogenous	?	?	?	Y	N	?	?	?
Lumps	N	N	N	N	N	N	N	N
Coarse Particles	N	N	N	N	N	N	N	N
Clear	T	T	Slightly T	Y	N	T	T	T
Color	whitish orange	orange yell.	lt. yell.	lt. yell.	white	lt. yell.	lt. yell.	lt. yell.
Viscosity (RT)	between low and med.	between low and med.	low	low	low	low	low	low

1. Qualitative.

Y.....Yes  
 N.....No  
 T.....Translucent

11-36

TABLE 6-30

## EPOXIES

- Formulation Processing -

Formulation No. F-	Steps (1)			
	(2)		(3)	
	(°F)	(min.)	(°F)	(hr./min.)
528-1A	73	3	150	4/15
-1B	73	3	"	43/30
529-1A	72	3	"	4/0
-1B	72	3	"	43/15
530-1A	74	3	"	3/40
-1B	74	3	"	42/55
531-1A	70 (4)	5	"	7/8
-1B	70 (4)	5	"	35/48
532-1A	70 (4)	2	"	7/50
-1B	70 (4)	2	"	36/30
533-1A	74	3	"	24/30
-1B	74	3	"	45/30
536-1A	76	3	"	9/30
-1B	76	3	"	47/30
537-1A	78	3	"	8/40
-1B	78	3	"	46/40

1. No degassing.
2. Blend ingredients at \_\_\_\_\_ °F for \_\_\_\_\_ minutes.
3. Cure/post cure.
4. Preblend resin components at room temperature to 150°F, max., before adding hardeners.

TABLE 6-31

## EPOXIES

- Characteristics (Cured/Post Cured) -

## Formulations

Properties (1)	528		529		530		531		532		533		536		537	
	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B
Cured	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Tacky	N	N	N	N	N	N	N	N	N	N	(4)	(4)	Y	N	S	N
Flexible	S	VS	S	VS	Y	S	Y	S	Y	VS	Y	Y	Y	Y	Y	Y
Memory	F	VS	Y	VS	Y	S	F	F	F	S	F	S	X	X	X	X
Cohesion	(X)(3)	(X)(3)	(X)(3)	(X)(3)	X	(X)(3)	X	(X)(3)	(X)(3)	(X)(3)	F	F	F	F	F	F
Tear Resistance	(X)(3)	(X)(3)	(X)(3)	(X)(3)	F	(X)(3)	F	(X)(3)	(X)(3)	(X)(3)	F	F	P	F	P	X
Crack Resistance (2)	(3)	(3)	(3)	(3)	X	P	X	(X)(3)	(X)(3)	(X)(3)	X	X	X	X	X	X
Crack Propagation (2)	(3)	(3)	(3)	(3)	F	F	X	(X)(3)	(X)(3)	(X)(3)	X	X	X	X	X	X
Porous	Y	Y	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Adheres to unclean alum. foil cup	S	VS	S	VS	S	VS	S	VS	VS	VS	S	X	X	S	S	VS
Cheesy	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Clear	Y	Y	Y	Y	Y	Y	Y	Y	N	N	Y	Y	Y	Y	Y	Y
Color	yell.	yell.	yell.	yell.	yell.	yell.	yell.	yell.	White	White	yell.	yell.	yell.	yell.	yell.	yell.
Hardness	97	90	97	97	96	96	96	98	96	98	---	---	85	85	78	84

Y.....Yes

N.....No

X.....Satisfactory

F.....Fair

VS.....Very Slight

S.....Slight

P.....Poor

NG.....Not Good

1. Qualitative

2. 180° bend (face-to-face contact)

3. Too stiff to test.

4. Hot: Y

Room Temp.: S

TABLE 6-32

EPOXY PROPERTIES COMPARISON  
(Ref. 6-5)

Properties	ERX-67 11.2 phr CL	42.9% ERX-67 57.1% D.E.R. 741 16.79 phr D.E.H. 61 1.29 phr DETA (F-537)	39.% ERX-67 61.% EPON 828 13 phr CL	100% EPON 828 14.5 phr CL
Bromine (%)	46.3	20.3	17.8	0.0
Flammability				
1. ASTM D-635-68	non-burning	---	non-burning	self-extinguishing
2. ASTM D-2863-70 (1)	>49.	---	39.	28.
3. Vertical Specimen (match ignition) (2)	Instant flame out	---	Instant flame out	30 sec. flame out
Tensile, elongation at break (%)	1.4	>100 (3)	6.0	6.5
Flexibility	rigid	flex. (4)	rigid	rigid

1. Oxygen Index Method (i.e. measure of %  $O_2$  in an  $O_2/N_2$  mixture necessary to support combustion.
2. ASTM D-2863-70 type specimen supported in vertical position and ignited at bottom with common paper book match. Flame activity reported after match completely burns out.
3. Estimated via hand pull.
4. See Table 6-31.

TABLE 6-33

## EPOXIES

(Test Specimens)

Component	S	Formulations (pbw)		
		597	598	600
D.E.R. 741	22	100.		
ERX-67	23	75.		
F-597-1	6			175.
F-598-1	6			18.08
D.E.H. 61	22		16.79	
DETA	30		1.29	

S.....Source (see Table 6-2)

TABLE 6-34

## EPOXIES

(Test Specimens)

- Formulation Processing -

Formulation No. F-	(2)		Steps (1) (3)		(4)	
	(°F)	(min.)	(°F)	(hrs./min.)	(°F)	(hrs./min.)
600-1	85.	55.	150.	12./30.	---	---
600-2A	78.	45.	"	9./30	---	---
-2B	78.	45.	R.T.	50./30.	150.	16./30.
600-3A	75.	40.	150.	17./30.	---	---
-3B	75.	40.	R.T.	5 days/ 15 hrs.	150.	24./15.

1. Hand blended for 5.-15. minutes at room temperature.
2. Degassed at \_\_\_\_\_ °F for \_\_\_\_\_ minutes under 29. in. mercury vacuum.
3. Cured at \_\_\_\_\_ °F for \_\_\_\_\_ hours/minutes.
4. Post cured at \_\_\_\_\_ °F for \_\_\_\_\_ hours/minutes.



TABLE 6-35  
EPOXIES  
PRELIMINARY FLAMMABILITY  
-TEST CONDITIONS/RESULTS-

		Specimen		
		600-3-6-1	600-3-6-2	600-3-6-3
O <sub>2</sub> Pressure (psia)		3.00	3.00	3.00
N <sub>2</sub> Pressure (psia)		7.00	7.00	7.00
Specimen length (in)		5.0	5.08	5.07
Specimen thick. (in)		0.070	0.076	0.076
Ignition time (sec)		30.	30.	30.
R	Burn time (sec)	36.	40.	40.
	flame-out glow-out	0.	0.	0.
E	Flame color	yellow	yellow	yellow
	Smoke   color amount (1)	black P	black S	black S
S	Sparkling (1)	N	N	N
	Sputtering (1)	S	slight	slight
U	Dripping flaming particles (1)	N	N	slight
L	Configuration (2)	Y	Y	Y
	Residue (3) (%)	70.	75.	75.
T	Melted (1)	S	S	S
S	Color in   exterior burn area   interior	black black	black black	black black
	Texture in   powdery burn area   crusty (4)	Y ?	Y ?	Y ?
Conclusion (5)		SE 4.0	SE 3.2	SE 4.2

1. N.....None    S.....Some    P.....Profuse

2. Generally similar to original specimen: Yes or No.

3. Amount left in (2).

4. Y.....Yes    N.....No.

5. NC.....Non combustible    SE.....Self-extinguishing in XX inches  
XX

NSE.....Non Self-extinguishing.

11-43

TABLE 6-36

URETHANE CANDIDATE MATERIALS (1)

Material	S	Visc. (cps @ °C)	M.P. (°C)	Br. (%)	P (%)	N (%)	Hydroxyl No.	F (2)	NCO (%)	F (2)	Mol. Wt.	Equivalent Wt. Calculation	Wt. W
FR-1138	33	---	75. - 98.	61. - 62.	---	---		(2)	---	---	262.	262./2.	131.
Dibromobutenediol (DBBD)	34	---	115.5 - 117.1	64. - 64.7	---	---	456.	(2)	---	---	245.8	245.8/2. 56.1K/456.	122.9 123.
Vircol 82	35	250. @ 25.	---	---	11.3	---	205.	2	---	---		56.1K/205.	274.
Fyrol 6	36	195. @ 22.8	---	---	12.2 - 12.6	5.2 - 5.8	~450.	(2)	---	---	231.	56.1K/450.	125.
Isonol FRP-8	37	200. @ 50.	---	---	7.5	---	380.		---	---		56.1K/380.	148.
Brominex 160P	38	28-34 K @ 24.4	---	34. - 36.	2.5 - 2.7	---	46. - 50.	2.4	---	---	~ 3000.	56.1K/48. 3000./2.4	1168. 1250.
Brominex 9107	39	536. @ R T	---	14.10	---		---	---	21.3	2.8	~1900.	4.2K/21.3	197.
Isonate 143L	40	30. @ 25.	---	---	---		---	---		2.1		---	144.
PAPI 901	41	80. @ 25.	---	---	---		---	---		2.3		---	133.

1. Material suppliers data except as otherwise indicated.

2. F.....Functionality

( ) ..... Assumed

TABLE 6-37

## URETHANE CANDIDATE MATERIALS

- Weight Comparison With Brominex 160P -  
(1)

	FR-1138 Br (2)	DBBD Br (2)	Vircol 82 P (3)	Fyrol 6 P (3)	Isonol FRP-8 P (3)
1. Br or P, mat'l. as rcvd. (%)	61.5	64.4	11.3	12.4	7.5
2. Br or P, mat'l. as rcvd. (gm/100. gm reactant)	61.5	64.4	11.3	12.4	7.5
3. Br or P, desired (i.e. B-160P) (%)	35.	35.	2.6	2.6	2.6
4. Mat'l. reqd. (gm/100 gm B-160P)	56.9	54.4	23.	21.	34.7

1. See Tables 6-2 and 6-36 for identification and properties of the materials.
2. No phosphorus.
3. No bromine.

TABLE 6-38

## URETHANE CANDIDATE MATERIALS

- Preblend Equivalents Comparison With Brominex 160P -

Case	Material	Br (gm)	P (gm)	Wt. (gm)	Equiv. Wt.	Calculation	Equivalents E
1	Brominex 160P	35.	2.6	100.	1168.	$E = \frac{100.}{1168.}$	0.0857
2	Vircol 82	---	11.3	100.	274.	$E = \frac{100.}{274.}$	0.365
3	DBBD (1)	35.	---	55.	123.	$E = \frac{55.}{123.}$	0.447
	Vircol 82	---	2.6	23.	274.	$E = \frac{23.}{274.}$	0.084
	Total	35.	2.6	78.	---	---	0.531
4	DBBD	35.	---	55.	123.	$E = \frac{55.}{123.}$	0.447
	Fyrol 6	---	2.6	21.	125.	$E = \frac{21.}{125.}$	0.168
	Total	35.	2.6	76.	---	---	0.615
5	Brominex 160P	35.	2.6	100.	1168.	$E = \frac{100.}{1168.}$	0.0857
	Vircol 82	---	1.13	10.	274.	$E = \frac{10.}{274.}$	0.0365
	Total	35.	3.73	110.	---	---	0.1222
6	Brominex 160P	35.	2.6	100.	1168.	$E = \frac{100.}{1168.}$	0.0857
	Vircol 82	---	2.26	20.	274.	$E = \frac{20.}{274.}$	0.0730
	Total	35.	4.86	120.	---	---	0.1587
7	Brominex 160P	175.	13.0	500.	1168.	$E = \frac{500.}{1168.}$	0.4285
	Vircol 82	---	11.3	100.	274.	$E = \frac{100.}{274.}$	0.3650
	Total	175.	24.3	600.	---	---	0.7935

TABLE 6-38 (cont)

## URETHANE CANDIDATE MATERIALS

- Preblend Equivalents Comparison With Brominex 160P -

Case	Material	Br (gm)	P (gm)	Wt. (gm)	Equiv. Wt.	Equivalents Calculation	E
8	Brominex 160P	35.	2.6	100.	1168.	$E = \frac{100.}{1168.}$	0.0857
	Vircol 82	---	4.52	40.	274.	$E = \frac{40.}{274.}$	0.1460
	Total	35.	7.12	140.	---	---	0.2317
9	Brominex 160P	35.	2.6	100.	1316.	$E = \frac{100.}{1316.}$	0.0760
10	Brominex 160P	35.	2.6	100.	1316.	$E = 100./1316.$	0.0760
	Vircol 82	---	2.26	20.	272.4	$E = 20./272.4$	0.0734
	Total	35.	4.86	120.	---	---	0.1494
11	Fyrol 6	---	12.4	100.	125.	$E = 100./125.$	0.800
12	Brominex 160P	35.	2.6	100.	1316.	$E = 100./1316.$	0.0760
	Fyrol 6	---	2.48	20.	125.	$E = 20./125.$	0.1600
	Total	35.	5.08	120.	---	---	0.2360

TABLE 6-39

## URETHANE CANDIDATE MATERIALS

- Formulation Comparison With Brominex 160P -  
(1)

Case	Material	Br (gm)	P (gm)	OH Equiv.	NCO Equiv.	NCO Equiv. Wt. (gm) Calculation	W
1	Brominex 160P	35.	2.6	0.0857	---	---	100.
	Isonate 143L	---	---	---	0.0857	(0.0857)(144.)	12.32
	Total	35. 31.2	2.6 2.32	0.0857 ---	0.0857 ---	---	112.32 100.
2	Vircol 82	---	11.3	0.365	---	---	100.
	Isonate 143L	---	---	---	0.365	(0.365)(144.8)	52.8
	Total	---	11.3 7.29	0.365 ---	0.365 ---	---	152.8 100.
3	DBBD <sup>(2)</sup> /Vircol 82	35.	2.6	0.531	---	---	78.
	Isonate 143L	---	---	---	0.531	(0.531)(144.)	76.4
	Total	35. 22.7	2.6 1.68	0.531 ---	0.531 ---	---	154.4 100.
4	DBBD/Fyrol 6	35.	2.6	0.615	---	---	76.
	Isonate 143L	---	---	---	0.615	(0.615)(144.)	88.6
	Total	35. 21.28	2.6 1.58	0.615 ---	0.615 ---	---	164.6 100.
5	Brominex 160P	35.	2.6	0.0857	---	---	100.
	PAPI 901	---	---	---	0.0857	(0.0857)(133.)	11.40
	Total	35. 31.4	2.6 2.33	0.0857 ---	0.0857 ---	---	111.40 100.
6	Brominex 160P	35.	2.6	0.0857	---	---	100.
	Brominex 9107	2.26	---	---	0.0857	(0.0857)(197.)	16.90
	Total	32.26 31.9	2.6 2.23	0.0857 ---	0.0857 ---	---	116.90 100.
7	B-160P/V-82 (10 pbw)	35.	3.73	0.122	---	---	110.
	Isonate 143L	---	---	---	0.122	(0.122)(144.)	17.58
	Total	35. 27.45	3.73 2.93	0.122 ---	0.122 ---	---	127.58 100.

Table 6-39 (cont)

## URETHANE CANDIDATE MATERIALS

- Formulation Comparison With Brominex 160P -  
(1)

Case	Material	Br (gm)	P (gm)	OH Equiv.	NCO Equiv.	NCO Equiv. Wt. (gm) Calculation	Wt. (gm) W
8	B-160P/V-82 (20 pbw)	35.	4.86	0.159	---	---	120.
	Isonate 143L	---	---	---	0.159	(0.159)(144.)	22.9
	Total	35. 24.5	4.86 3.41	0.159 ---	0.159 ---	---	142.9 100.
9	B-160P/V-82 (20 pbw)	175.	24.3	0.7935	---	---	600.
	PAPI 901	---	---	---	0.7935	(0.7935)(133.)	105.4
	Total	175. 24.84	24.3 3.45	0.7935 ---	0.7935 ---	---	705.4 100.
10	B-160P/V-82 (10 pbw)	35.	3.73	0.122	---	---	110.
	Brominex 9107	3.39	---	---	0.122	(0.122)(197.)	24.1
	Total	38.39 28.65	3.73 2.79	0.122 ---	0.122 ---	---	134.1 100.
11	Brominex 160P	35.	2.6	0.0760	---	---	100.
	Isonate 143L	---	---	---	0.0760	(0.0760)(144.8)	11.
	Total	35. 31.53	2.6 2.34	0.0760 ---	0.0760 ---	---	111. 100.
12	B-160P/V-82 (20 pbw)	35.	4.86	0.1494	---	---	120.
	Isonate 143L	---	---	---	0.1494	(0.1494)(144.8)	21.66
	Total	35. 24.72	4.86 3.44	0.1494 ---	0.1494 ---	---	141.66 100.
13	Brominex 160P	35.	2.6	0.0760	---	---	100.
	PAPI 901	---	---	---	0.0760	(0.0760)(134.3)	10.21
	Total	35. 31.71	2.6 2.36	0.0760 ---	0.0760 ---	---	110.21 100.
14	Fyrol 6	---	12.4	0.800	---	---	100.
	PAPI 901	---	---	---	0.800	(0.8)(134.4)	107.52
	Total	---	12.4 5.97	0.800 ---	0.800 ---	---	207.52 100.
15	B-160P/F-6 (20 pbw)	35.	5.08	0.2360	---	---	120.00
	Isonate 143L	---	---	---	0.2360	(0.236)(144.8)	34.16
	Total	35. 22.7	5.08 3.29	0.2360 ---	0.2360 ---	---	154.16 100.
16	B-160P/F-6 (20 pbw)	35.	5.08	0.2360	---	---	120.00
	PAPI 901	---	---	---	0.2360	(0.236)(134.4)	31.75
	Total	35. 23.1	5.8 3.35	0.2360 ---	0.2360 ---	---	151.75 100.

1. See Table 6-38

2. DBSD.....Dibromobutenediol.

TABLE 6-40

URETHANES  
(Phase I)

Formulations (pbw)

Component	S	541	542	543	545	546	547	548	544	552	554	551	553	555	556	557
Brominex 160P	38	100.	100.	100.	100.	400.	100.	400.	100.	100.	400.	100.	100.	400.	100.	150.
Vircol 82	35														40.	
F-545-1	6					100.2					100.2			100.2		100.2
F-547-1	6							100.2								
F-556-1	6															350.
Isonate 143L	40	14.78	14.78	14.78		73.92		73.92								
PAPI 901	41								13.68	13.68	68.4					82.08
Brominex 9107	39											20.28	20.28	101.4		
T-9	42		0.2		0.2					0.2			0.2			
T-12	43			0.2			0.2									

S.....Source (See Table 6-2)

67-11



TABLE 6-40 (cont)

URETHANES  
(Phase I)

Formulations (pbw)

Component	S	558	559	560	561	562	566	563	564	565	567	571	572	574	575
Brominex 160P	38	300.	300.	300.	300.	150.	100.					100.		100.	
Vircol 82	35								20.				20.		20.
F-545-1	6	200.4	200.4	200.4	200.4	100.2									
F-556-1	6					350.									
F-566-1	6							100.1	100.1	100.1	100.1				
F-571-1	6												100.15		
F-574-1	6														100.25
Isonate 143L	40	73.92						14.3	25.99		13.2		25.99		25.99
PAPI 901	41		68.4			75.24	126.48			12.25					
Brominex 9107	39			101.4											
T-9	42						0.1					0.15		0.25	

S.....Source (See Table 6-2)

TABLE 6-41

## URETHANE CANDIDATE MATERIALS (1)

Material	Hydroxyl		NCO		Equivalent Wt.	
	No.	F (2)	(%)	F (2)	Calculation	W
Brominex 160P	42.6 (1)	2.4	---	---	56.1K/42.6	1316.
Vircol 82	206. (1)	2.	---	---	56.1K/206.	272.4
Isonate 143L	---	---	---	2.1	---	144.8 (1)
PAPI 901	---	---	---	2.3	---	134.4 (1)

1. Lot data.
2. Functionality.

TABLE 6-42

URETHANES  
(Phase I)  
- Formulation Processing -

Formulation No. F-	(1)		(2)		(3)		Steps		(5)		(6)	(7)
	(°F)	(min.)	(°F)	(min.)	(°F)	(min.)	(°F)	(min.)	(°F)	(min.)	(hrs./min.)	(hrs./min.)
541-1A	65.	2.	---	---	---	---	---	---	68.	25.	50./-	---
-1B	"	"	---	---	---	---	---	---	"	"	"	49./40.
542-1A	68.	3.	---	---	---	---	---	---	70.	30.	23./-	---
-1B	"	"	---	---	---	---	---	---	"	"	"	24./-
543-1A	73.	4.	---	---	---	---	---	---	74.	25.	18./-	---
-2A	"	"	---	---	---	---	---	---	"	"	"	24./-
545-1	70.	3.	---	---	---	---	---	---	72.	30.	---	---
546-1A	72.	5.	---	---	---	---	---	---	73.	28.	23./-	---
-1B	"	"	---	---	---	---	---	---	"	"	"	73./15.
547-1	"	4.	---	---	---	---	---	---	"	30.	---	---
548-1A	71.	3.	---	---	---	---	---	---	71.	24.	17./45.	---
-1B	"	"	---	---	---	---	---	---	"	"	"	73./50.
544-1A	"	"	---	---	---	---	---	---	72.	46.	96./-	---
-1B	"	"	---	---	---	---	---	---	"	"	"	45./-
552-1A	76.	"	---	---	---	---	---	---	(8)		4./20.	---
-1B	"	"	---	---	---	---	---	---	"		"	47./-
554-1A	---	---	248.	5.	79.	5.	79.	3.	80.	27.	74./-	---
-1B	---	---	"	"	"	"	"	"	"	"	"	45./-

TABLE 6-42.(cont)

URETHANES  
(Phase I)

- Formulation Processing -

Formulation No. F-	Steps											
	(1) (°F) (min.)	(2) (°F) (min.)	(3) (°F) (min.)	(4) (°F) (min.)	(5) (°F) (min.)	(6) (hrs./min.)	(7) (hrs./min.)					
551-1A	68. 3.	---	---	---	---	70. 9.	6 days					
-1B	" "	---	---	---	---	" "	~ 24 days					
553-1A	248. 5.	---	---	---	---	76. 65.	~ 3 "					
-1B	" "	---	---	---	---	" "	~ 2 days					
555-1A	---	248. 5.	76. 5.	76. 2.	77. 25.	5 days/20 hrs.	---					
-1B	---	" "	" "	" "	" "	" "	~ 25 days					
556-1	239. 15.	---	---	---	<239. 15.	---	---					
557-1	---	239. 15.	<239. 5.	78. 3.	79. 44.	~ 7 days	---					
558-1A	---	239. 5.	<239. (9) 5.	76. 5.	76. 30.	8./10.	---					
-1B	---	" "	" "	" "	" "	" "	85./20.					
559-1A	---	" 10.	" 10.	75. 4.	" 48.	5./10.	---					
-1B	---	" "	" "	" "	" "	" "	85./20.					
560-1A	---	" "	" "	77. "	78. 22.	6 days/10 hrs.	---					
-1B	---	" "	" "	" "	" "	" "	~ 17 days					
561-1A	---	" "	" "	82. 3.	82. 18.	55./45.	---					
-1B	---	" "	" "	" "	" "	" "	15./-					
562-1A	---	239. 10.	" "	79. "	80. 20.	53./10.	---					
-1B	---	" "	" "	" "	" "	" "	15./-					

TABLE 6-42c (cont)

## URETHANES

(Phase I)

- Formulation Processing -

Formulation No. F-	Steps											
	(1) (°F)	(min.)	(2) (°F)	(min.)	(3) (°F)	(min.)	(4) (°F)	(min.)	(5) (°F)	(min.)	(6) (hrs./min.)	(7) (hrs./min.)
566-1	70.	4.	---	---	---	---	---	---	70.-80.	~24 hrs.	---	---
563-1A -1B	76. "	3. "	---	---	---	---	---	---	76. "	~ 5-1/2 hrs. "	47./30, "	--- 48./-
564-1A -1B	---	---	74. "	4. "	~75. "	~72. hrs. "	74. "	3. "	74. "	60. "	5 days/19. hrs. "	--- 85./50.
565-1A -1B	76. "	4. "	---	---	---	---	---	---	77. "	" "	24./15. "	--- 24./30.
567-1A -1B	82. "	4. "	---	---	---	---	---	---	82. "	10. "	20./35. "	--- 71./15.
571-1	75.	4.	---	---	---	---	---	---	~75.	8. hrs./ 30. min.	---	---
572-1A -1B	---	---	84. "	3. "	84. "	2. hrs. "	84. "	3. "	84. "	15. "	47./45. "	--- 64./35.
574-1	77.	3.	---	---	---	---	---	---	77.	6. hrs./ 10. min.	---	---
575-1A -1B	---	---	76. "	3. "	76. "	10. "	76. "	4. "	76. "	20. "	24./30. "	---

1. Blended at \_\_\_\_\_°F for \_\_\_\_\_ minutes.
2. Preblended polyols at \_\_\_\_\_°F for \_\_\_\_\_ minutes.
3. Degassed at \_\_\_\_\_°F for \_\_\_\_\_ min. under 29 in. mercury, cooled, and added diisocyanate.
4. Blended at \_\_\_\_\_°F for \_\_\_\_\_ minutes.

5. Degassed at \_\_\_\_\_°F for \_\_\_\_\_ min. under 29 in. mercury.
6. Cured at 150°F for \_\_\_\_\_ hours.
7. Post cured at 150°F for \_\_\_\_\_ hours.
8. Viscosity increased too rapidly to degas.

TABLE 6-43

URETHANES  
(Phase I)

- Characteristics -

Properties (1)	Formulations																	
	541-1		542-1		543-1		545-1	546-1		547-1	548-1		544-1		552-1		554-1	
	A	B	A	B	A	B		A	B		A	B	A	B	A	B	A	B
Homogenous (2)	Y	Y	Y	Y	(8)	(8)	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Lumps (2)	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Coarse Particles (2)	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Clear (2)	Y	Y	Y	Y	N	N	Y	Y	Y	Y	Y	Y	Y	Y	N	N	Y	Y
Color (2)	yell.	yell.	yell.	yell.	white	white	orange	yell.	yell.	orange	yell.	yell.	brn.	brn.	brn.	brn.	brn.	brn.
Viscosity (RT) (2)	med.	med.	(7)	(7)	(7)	(7)	high med.	med.	med.	high med.	high	high	med.	med.	high (7)	high (7)	med.	med
Cured	N	?	?	?	?	?	---	?	Y	---	?	?	?	?	?	Y	?	?
Tacky	Y	S	S	VS	S	VS	---	Y	N	---	Y	S	Y	VS	Y	N	Y	VS
Flexible	Y	Y	---	Y	---	Y	---	Y	Y	---	Y	Y	Y	Y	Y	Y	Y	Y
Memory	Y	Y	---	Y	---	Y	---	Y	Y	---	Y	Y	Y	Y	Y	Y	Y	Y
Cohesion	F	F	---	(8)	---	(8)	---	F	F	---	F	F	F	F	(8)	(8)	F	F
Tear Resistance	NG	NG	---	(8)	---	(8)	---	F	F	---	F	F	F	F	(8)	(8)	F	F
Crack Resistance (3)	(5)	X	---	(8)	---	(8)	---	X	X	---	X	X	X	X	X	X	X	X
Crack Propagation (3)	(5)	X	---	(8)	---	(8)	---	X	X	---	X	X	X	X	X	X	X	X
Porous	S	S	---	Y	---	Y	---	S	S	---	Y	Y	N	N	Y	Y	N	N
Adheres to unclean alum. foil cup	---	---	Y	Y	N	---	---	---	---	---	---	---	---	---	N	F	---	---
Cheesy	N	N	---	N	---	N	---	N	N	---	N	N	N	N	N	N	N	N
Clear (4)	(6)	(6)	(8)	(8)	(8)	(8)	---	Y	Y	---	Y	Y	Y	Y	(8)	(8)	Y	Y
Color (4)	brn.	brn.	brn.	brn.	brn.	brn.	---	brn.	dk brn.	---	brn.	dk.brn.	brn.	brn.	brn.	dk.brn.	brn.	brn.

TABLE 5-43. (cont.)

URETHANES  
(Phase I)  
- Characteristics -

Properties (1)	Formulations																	
	551-1		553-1		555-1		556-1	557-1	558-1		559-1		560-1		561-1		562-1	
	A	B	A	B	A	B			A	B	A	B	A	B	A	B	A	B
Homogenous (2)	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Lumps (2)	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Coarse Particles (2)	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Clear (2)	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Color (2)	yell.	yell.	yell.	yell.	yell.	yell.	yell.	brn.	yell.	yell.	brn.	brn.	yell.	yell.	brn.	brn.	brn.	brn.
Viscosity (RT) (2)	low med.	low med.	(7)	(7)	between med. and high		low	between low and med.	med.	med.	med.	med.	med.	med.	med.	med.	low med.	low med.
Cured	N	N	?	?	?	?	---	N	Y	Y	Y	Y	N	?	Y	Y	?	Y
Tasky	Y	Y	Y	VS	Y	S	---	Y	VS	VS	VS	N	Y	Y	N	N	S	N
Flexible	Y	Y	Y	Y	Y	Y	---	(9)	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Memory	F	Y	Y	Y	Y	Y	---	(9)	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Cohesion	NG	NG	F	F	F	F	---	(9)	F	F	F	F	NG	NG	F	F	X	X
Tear Resistance	NG	NG	NG	NG	NG	NG	---	(9)	F	F	P	P	NG	NG	P	P	P	P
Crack Resistance (3)	X	X	X	X	X	X	---	(9)	X	X	X	X	X	X	X	X	X	X
Crack Propagation (3)	X	X	X	X	X	X	---	(9)	X	X	X	X	X	X	X	X	X	X
Porous	N	N	N	N	N	N	---	---	N	N	N	N	N	N	N	N	N	N
Adheres to unclean alum. foil cup	---	---	N	N	Y	S	---	(9)	S	S	S	N	F	F	N	N	Y	Y
Cheesy	N	N	N	N	N	N	---	(9)	N	N	N	N	(9)	N	N	N	N	N
Clear (4)	Y	Y	Y	Y	Y	Y	---	---	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Color (4)	brn. dk.bm. lt.bm. brn. brn.						---	brn.	brn. dk.bm. brn. dk.bm. brn. dk.bm. brn. brn.									

5-11

TABLE 6-43.(cont)

URETHANES  
(Phase I)  
- Characteristics -

Properties (1)	566-1	563-1		564-1		565-1		567-1		Formulations 571-1	572-1		574-1	575-1	
		A	B	A	B	A	B	A	B		A	B		A	B
Homogenous (2)	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Lumps (2)	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Coarse Particles (2)	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Clear (2)	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Color (2)	orange	yell. bm.	yell. brn.	lt. bm.	lt. brn.	bm.	brn.	lt. brn.	lt. brn.	orange	lt. brn.	lt. brn.	orange	lt. brn.	lt. brn.
Viscosity (RT) (2)	high med.	(10)	(10)	med.	med.	med.	med.	med.	med.	high med.	med.	med.	high med.	med.	med.
Cured	---	?	Y	N	?	?	?	?	?	---	N	?	---	?	
Tacky	---	Y	N	Y	S	S	S	Y	Y	---	Y	S	---	Y	
Flexible	---	Y	Y	Y	Y	Y	Y	Y	Y	---	Y	Y	---	Y	
Memory	---	Y	Y	Y	Y	Y	Y	Y	Y	---	Y	Y	---	Y	
Cohesion	---	F	F	NG	F	F	F	P	P	---	P	F	---	F	
Tear Resistance	---	NG	NG	NG	F	P	P	P	P	---	P	P	---	P	
Crack Resistance (3)	---	X	X	NG	X	X	X	X	X	---	X	X	---	X	
Crack Propagation (3)	---	X	X	NG	X	X	X	X	X	---	X	X	---	X	
Porous	---	(11)	(11)	(14)	(14)	(14)	(14)	S	S	---	(14)	(14)	---	(14)	(14)
Adheres to unclean alum. foil cup	---	(12)	(12)	---	---	---	---	---	---	---	---	---	---	---	---
Cheesy	---	N	N	N	N	N	N	N	N	---	(9)	S(9)	---	S(9)	
Clear (4)	---	Y	Y	Y	Y	Y	Y	Y	Y	---	Y	Y	---	---	
Color (4)	---	brn.	brn	brn	brn	brn.	brn.	lt.bm.	brn.	---	brn.	dk.brn.	---	lt.brn.	



TABLE 6-43 (cont)

URETHANES  
(Phase I)

Y.....Yes	X.....Satisfactory	VS.....Very Slight	P.....Poor
N.....No	F.....Fair	S.....Slight	NG.....Not Good

1. Qualitative.
2. Before cure.
3. 180° bend (face-to-face contact).
4. After cure.
5. Faces stuck together.
6. Slightly translucent.
7. Viscosity rapidly increased.
8. Foamed.
9. Gummy.
10. Medium-very high.
11. Strip: N  
Sheet: Y  
Block: foamed top 1/3
12. Adheres well to Mylar.
14. Strip: Y  
Sheet: S  
Block: Y

TABLE 6-44

URETHANES  
(Phase II)

Component	S	Formulations (pbw)								
		576	577	578	579	580	581	582	583	584
Brominex 160P	38	75.	25.		75.	25.		75.	25.	
F-576-1	6		88.2	88.2						
F-571-1 (1)	6			25.15			25.15			25.15
F-579-1	6					87.25	87.25			
F-582-1	6								95.28	95.28
Isonate 143L	40	13.20								
PAPI 901	41				12.25					
Brominex 9107	39							20.28		

S.....Source (See Table 6-2).

1. See Table 6-40.

TABLE 6-45

URETHANES  
(Phase II)

- Formulation Processing -

Formulation No. F-	(1)		Steps (2)		(3)	
	(°F)	(min.)	(°F)	(min.)	(°F)	(hrs./min.)
576	83.	3.	83.	7.	150.	-/79
577	79.	2.	79.	15.	"	45/-
578	79.	2.	79.	15.	"	44/45
579	83.	3.	83.	5.	"	-/75
580	79.	3.	79.	15.	"	44/10
581	79.	3.	79.	15.	"	44/10
581	79.	3.	79.	15.	"	43/50
582	83.	2.	83.	10.	"	-/73
583	81.	4.	81.	15.	"	42/-
584	80.	4.	80.	15.	"	43/-

1. Blended at \_\_\_\_\_ °F for \_\_\_\_\_ minutes.

2. Degassed at \_\_\_\_\_ °F for \_\_\_\_\_ minutes under 29 in. mercury vacuum.

3. Cured at \_\_\_\_\_ °F for \_\_\_\_\_ hours/minutes.

TABLE 6-46

## URETHANES

PRELIMINARY FLAMMABILITY  
-TEST CONDITIONS/RESULTS-

		Specimen	
		567-1B-6-1	567-1B-6-2
O <sub>2</sub> pressure (psia)		3.00	3.00
N <sub>2</sub> pressure (psia)		7.00	7.00
Specimen length (in)		5.0	5.0
Specimen thick. (in)		0.078	0.080
Ignition time (sec)		30.	30.
R	Burn time (sec)	31.	35.
	flame-out glow-out	0.	0.
E	Flame color	yellow	yellow
	Smoke   color amount (1)	black P	black S
S	Sparkling (1)	N	N
	Sputtering (1)	N	N
U	Dripping flaming particles (1)	N	N
	Configuration (2)	Y	Y
L	Residue (3) (%)	75.	65.
	Melted (1)	N	N
S	Color in   exterior burn area   interior	black black	black black
	Texture in   powdery burn area   crusty (4)	Y Y	Y Y
Conclusion (5)		SE 4.7	SE 4.0

1. N.....None    S.....Some    P.....Profuse

2. Generally similar to original specimen: Yes or No.

3. Amount left in (2).

4. Y.....Yes    N.....No

5. NC.....Non combustible    SE.....Self-extinguishing in XX inches    NSE.....Non Self-extinguishing  
XX

TABLE 6-47  
EPOXY-URETHANES  
(Pre-Reacted Urethane)

Component	S	Formulations (pbw)		
		538	539	540
XD 3599.01	44	100.	100.	100.
ERX-67	23	75.	75.	75.
DEH-61	22	21.71	17.37	
DETA	30		3.10	
DMPA	45			25.01

S.....Source (See Table 6-2)

TABLE 6-48

EPOXY-URETHANES  
(Pre-Reacted Urethane)

- Formulation Processing -

Formulation No. F-	Steps (5)							
	(1) (°F)	(1) (min.)	(2) (°F)	(2) (min.)	(3) (°F)	(3) (hr./min.)	(4) (°F)	(4) (hr./min.)
538-1A	150.	5.	76.	4.	150.	4./10.	---	---
-1B	"	"	"	"	"	"	150.	16./20.
539-1A	"	"	73.	"	150.	4./30.	---	---
-1B	"	"	"	"	"	"	150.	21./16.
540-1	"	"	77.	"	"	4./45.	---	---

1. Preblend the epoxy resins at \_\_\_\_\_°F for \_\_\_\_\_ minutes, then cool.
2. Add the hardener(s) and reblend at \_\_\_\_\_°F for \_\_\_\_\_ minutes.
3. Cure at \_\_\_\_\_°F for \_\_\_\_\_ hours/minutes.
4. Post cure at \_\_\_\_\_°F for \_\_\_\_\_ hours/minutes.
5. No degassing carried out.

TABLE 6-49

EPOXY-URETHANES  
(Pre-Reacted Urethane)

- Characteristics -

Properties (1)	Formulations				
	538		539		540
	A	B	A	B	
Homogenous (2)	?	?	?	?	Y
Lumps (2)	N	N	N	N	N
Coarse Particles (2)	N	N	N	N	N
Clear (2)	N	N	N	N	Y
Color (2)	lt.yell.	lt.yell.	lt.yell.	lt.yell.	lt.yell.
Viscosity (R.T.) (2)	med.	med.	med.	med.	s.less med.
Cured	?	Y	Y	Y	Y
Tacky	(5)	N	N	N	N
Flexible	S	(6)	N	N	(6)
Memory	---	---	---	---	---
Cohesion	X	X	X	X	X
Tear Resistance	X	X	X	X	X
Crack Resistance (3)	(7)	(7)	(7)	(7)	(7)
Crack Propagation (3)	(7)	(7)	(7)	(7)	(7)
Porous	S	S	Y	Y	?
Adheres to unclean alum. foil cup	N	N	N	N	N
Cheesy	N	N	N	N	N
Color (4)	s.yell.	s.yell.	s.yell.	s.yell.	(8)
Clear (4)	Y	Y	Y	Y	(9)

Y.....Yes  
N.....NoX.....Satisfactory  
F.....FairVS.....Very Slight  
S.....SlightP.....Poor  
NG.....Not Good

1. Qualitative.
2. Before cure.
3. 180° bend (face-to-face contact).
4. After cure.
5. Hot: Yes  
Cold: No

6. Brittle.
7. Unbendable.
8. Strip: White  
R.T.: Yell.
9. Strip: N  
R.T.: Y

TABLE 6-50  
EPOXY-URETHANES  
(Co-Reacted)

Component	S	Formulations (pbw)										
		568	569	570	573	585	586	587	588	589	590	591
ERX-67	23	100.	100.	100.	100.		100.		100.		100.	100.
Brominex 160P	38									50.	274.25	274.25
F-571-1 (1)	6	549.32		549.32	549.32	5.	549.32	5.	549.32			
F-585-1	6						4.76					
F-587-1	6								4.76			
F-574-1(1)	6									50.13	274.94	274.94
Vircol 82	35				109.7							
Fyrol 6	46									20.		109.7
AF-2	6					1.						
AF-4	6							1.				
Isonate 143L	40		144.6	144.6	202.5		144.6		144.6			
PAPI 901	41									31.75	134.7	276.06

S....Source (See Table 6-2)

1. See Table 6-40.



TABLE 6-51

## EPOXY-URETHANE ELEMENTAL ANALYSIS

- UNMODIFIED (1) -  
(Calculated)

Material	Cmpd. Wt. (gm)	Bromine		Phosphorus		Nitrogen (3)		Nitrogen (4)	
		Calculation	(gm)	Calculation	(gm)	Calculation	(gm)	Calculation	(gm)
ERX-67	100.	(51.5) (100.)/100. (2)	51.5	---	---	(3.18) (100.)/100.	3.18	(3.18) (100.)/100.	3.18
Brominex 160P	548.5	(35.) (548.5)/100.	192.0	(2.6) (548.5)/100.	14.28	---	---	---	---
Stannous octoate	(5.485) (0.15) = 0.82	---	---	---	---	---	---	---	---
Isonate 143L	144.6 (5)	---	---	---	---	(11.2) (144.6)/100.	16.19	(2.1) (11.2) (144.6)/ (100.) (2.)	16.98
Total	793.92	---	243.5	---	14.28	---	19.37	---	20.16
	100.	---	30.7	---	1.80	---	2.45	---	2.54

1. See F-570, Table 6-50.

2. 54.3%, if pure N,N-diglycidyl-2,4,6-tribromoaniline.

3. I-143L assumed similar to diphenylmethane diisocyanate (i.e. approximate functionality = 2.0, 11.2% N) (Ref. 6-11).

4. I-143L assumed essentially similar to diphenylmethane diisocyanate (i.e. actual functionality = 2.1) (Ref. 6-12).

5. Based on 1.2 times stoichiometric.

TABLE 6-52

EPOXY-URETHANES  
(Co-Reacted)

- Formulation Processing -

Formulation No. F-	Steps															
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	(°F)	(min.)	(°F)	(min.)	(°F)	(min.)	(°F)	(min.)	(°F)	(min.)	(°F)	(hrs./min.)	(°F)	(hrs./min.)	(°F)	(hrs./min.)
568-1A	82.	3.	---	---	---	---	---	---	82.	5.	RT	6 days/ 21. hrs.	---	---	---	---
-1B	"	"	---	---	---	---	---	---	"	"	150.	"	---	---	---	---
569-1A	79.	2.	---	---	---	---	---	---	79.	"	RT	6 days/ 16. hrs.	---	---	---	---
-1B	"	"	---	---	---	---	---	---	"	"	150.	"	---	---	---	---
570-1A	---	---	79.	3.	79.	15.	79.	3.	"	15.	"	41./5.	---	---	---	---
-1B	---	---	"	"	"	"	"	"	"	"	"	"	150.	24./-	---	---
570-2-1	---	---	83.	"	83.	"	83.	"	83.	"	"	14./0	---	---	---	---
-2-2	---	---	"	"	"	"	"	"	"	"	"	"	150.	23./-	---	---
-2-3	---	---	"	"	"	"	"	"	"	"	"	"	"	"	150.	18./30
573-1-1	---	---	73.	"	73.	"	73.	"	73.	"	"	31./15.	---	---	---	---
-1-2	---	---	"	"	"	"	"	"	"	"	"	"	150.	18./10.	---	---

1. Blended @ \_\_\_\_\_ °F for \_\_\_\_\_ minutes.
2. Preblended polyol(s) (and epoxy) @ \_\_\_\_\_ °F for \_\_\_\_\_ minutes.
3. Degassed @ \_\_\_\_\_ °F for \_\_\_\_\_ min. under 29. in. mercury, cooled, and added diisocyanate.
4. Blended @ \_\_\_\_\_ °F for \_\_\_\_\_ minutes.
5. Degassed @ \_\_\_\_\_ °F for \_\_\_\_\_ min. under 29. in. mercury.
6. Cured @ \_\_\_\_\_ °F for \_\_\_\_\_ hrs./min.
7. Post cured @ \_\_\_\_\_ °F for \_\_\_\_\_ hrs./min.
8. Additional post cure @ \_\_\_\_\_ °F for \_\_\_\_\_ hrs./min.

TABLE 6-52 (cont)

EPOXY-URETHANES  
(Co-Reacted)

- Formulation Processing -

Formulation No. F-	(1)		(2)		(3)		(4) Steps		(5)		(6)		(7)		(8)	
	(°F)	(min.)	(°F)	(min.)	(°F)	(min.)	(°F)	(min.)	(°F)	(min.)	(°F)	(hrs./min.)	(°F)	(hrs./min.)	(°F)	(hrs./min.)
570-3	---	---	84.	3.	84.	15.	84.	3.	84.	10.	150.	21./0	150.	26./15.	---	---
585-1	86.	3.	---	---	---	---	---	---	86.	30.	---	---	---	---	---	---
586-1	---	---	78.	3.	78.	15.	78.	3.	78.	7.	150.	19./50.	150.	33./50.	---	---
587-1	84.	3.	---	---	---	---	---	---	84.	30.	---	---	---	---	---	---
588-1	---	---	78.	3.	78.	15.	78.	3.	78.	5.	150.	13./30.	150.	33./50.	---	---
589-1	---	---	---	---	---	---	79.	4.	79.	5.	---	---	---	---	---	---
590-1	---	---	77.	5.	77.	15.	77.	4.	77.	30.	150.	54./20.	---	---	---	---
591-1	---	---	77.	5.	77.	10.	77.	10.	77.	40.	150.	53./15.	---	---	---	---

TABLE 6-53

EPOXY-URETHANES  
(Co-Reacted)

- Characteristics -

Properties (1)	568-1		569-1		570-1		570-2			573-1		590	591
	A	B	A	B	A	B	1	2	3	1	2		
Homogenous (2)	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Lumps (2)	N	N	N	N	N	N	N	N	N	N	N	N	N
Coarse Particles (2)	N	N	N	N	N	N	N	N	N	N	N	N	N
Clear (2)	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Color (2)	yell.	yell.	yell.	yell.	yell.	yell.	yell.	yell.	bril	lt. brn.	lt. brn.	lt. brn.	lt. brn.
Viscosity (RT) (2)	med.	med.	low	low	med.	med.	med.	med.	med.	low med.	low med.	med.	low med.
Cured	N (5)	N (5)	N (6)	N (6)	Y	Y	N	?	Y	N	Y	Y	Y
Tacky	---	---	---	---	N	N	Y	N	N	Y	N	N	N
Flexible	---	---	---	---	Y	Y	Y	Y	Y	Y	Y	Y	(10)
Memory	---	---	---	---	Y	Y	Y	Y	Y	Y	Y	Y	(10)
Cohesion	---	---	---	---	F	X	P	X	X	P	F	X	(10)
Tear Resistance	---	---	---	---	F	F	P	F	F	P	F	F	(10)
Crack Resistance (3)	---	---	---	---	X (7)	X (7)	X	X	X	X	X	X	(10)
Crack Propagation (3)	---	---	---	---	X (7)	X (7)	X	X	X	X	X	X	(10)
Porous	---	---	---	---	S	S	(9)	(9)	(9)	Y	Y	Y	(10)
Adheres to unclean alum. foil cup	---	---	---	---	S	---	---	---	---	---	---	F	P
Cheesy	---	---	---	---	N	N	N	N	N	N	N	N	N
Clear (4)	Y	Y	Y	Y	(8)	(8)	Y	Y	Y	Y	Y	Y	(10)
Color (4)	yell.	yell.	yell.	lt. brn.	lt. brn.	lt. brn.	lt. brn.	lt. brn.	lt. brn.	yell.	lt. brn.	brn.	brn.

TABLE 6-53 (cont)

EPOXY-URETHANES  
(Co-Reacted)

Y.....Yes	X.....Satisfactory	VS.....Very Slight	P.....Poor
N.....No	F.....Fair	S.....Slight	NG.....Not Good

1. Qualitative.
2. Before cure.
3. 180° bend (face-to-face contact).
4. After cure.
5. No change.
6. Surface gel.
7. Approx. 1/8 in. thick.
8. Slightly translucent.
9. Strip: Y on bottom  
Block: Very few  
Sheet: Some.
10. Gelled during degassing; profuse voids.

TABLE 6-54  
EPOXY-URETHANE ELEMENTAL ANALYSIS

- Vircol 82 Modified (1) -  
(Calculated)

Material	Cmpd. Wt. (gm)	Bromine Calculation	(gm)	Phosphorus Calculation	(gm)	Nitrogen (3) Calculation	(gm)	Nitrogen (4) Calculation	(gm)
ERX-67	100.	(51.5) (100.)/100. (2)	51.5	---	---	(3.18) (100.)/100.	3.18	(3.18) (100.)/100.	3.18
Brominex 160P	548.5	(35.) (548.5)/100.	192.0	(2.6) (548.5)/100.	14.28	---	---	---	---
Stannous octoate	(5.485) (0.15) = 0.82	---	---	---	---	---	---	---	---
Vircol 82	109.7	---	---	(11.3) (109.7)/100.	12.38	---	---	---	---
Isonate 143L	202.5	---	---	---	---	(11.2) (202.5)/100.	22.7	(2.1) (11.2) (202.5)/ (100.) (2.)	23.81
Total	961.52	---	243.5	---	26.66	---	25.88	---	26.99
	100.	---	25.33	---	2.77	---	2.69	---	2.81

1. See F-573, Table 6-50.

2. 54.3%, if pure N, N-diglycidyl-2,4,6-tribromoaniline.

3. I-143L assumed similar to diphenylmethane diisocyanate (i.e. approximate functionality = 2.0, : 11.2% N) (Ref. 6-11).

4. I-143L assumed essentially similar to diphenylmethane diisocyanate (i.e. actual functionality = 2.1) (Ref. 6-12).

5. Based on 1.14 times stoichiometric.

TABLE 6-55  
EPOXY-URETHANE ELEMENTAL ANALYSIS

Material	Cmpd. Wt. (gm)	Bromine		Phosphorus		Nitrogen (3)		Nitrogen (4)	
		Calculation	(gm)	Calculation	(gm)	Calculation	(gm)	Calculation	(gm)
ERX-67	100.	(51.5) (100.)/100. (2)	51.5	---	---	(3.18) (100.)/100.	3.18	(3.18) (100.)/100.	3.18
Brominex 160P	548.5	(35.) (548.5)/100.	192.0	(2.6) (548.5)/100.	14.28	---	---	---	---
Stannous octoate	(5.485) (0.125) = 0.69	---	---	---	---	---	---	---	---
PAPI 901	134.7 (5)	---	---	---	---	(11.0) (134.7)/100.	14.82	(2.3) (11.0) (134.7)/ (100.) (3.0)	11.37
Total	783.89	---	243.5	---	14.28	---	18.00	---	14.55
	100.	---	31.1	---	1.82	---	2.30	---	1.86

1. See F-590, Table 6-50.

2. 54.3%, if pure N, N-diglycidyl-2,4,6-tribromoaniline.

3. PAPI 901 assumed similar to polymethylene polyphenylisocyanate (i.e. approximate functionality) = 3.0, 11.0% N (Ref. 6-13).

4. PAPI 901 assumed essentially similar to polymethylene polyphenylisocyanate (i.e. actual functionality = 2.3) (Ref. 6-14).

5. Based on 1.2 times stoichiometric.

TABLE 6-56  
EPOXY - URETHANES  
PRELIMINARY FLAMMABILITY  
-TEST CONDITIONS/RESULTS-

		570- 2C-6-1	570- 2C-6-2	573-1B- -2-6-1	Specimen 573-1B- 2-6-2	573-1B- 2-6-3	590- 2A-6-2	590- 2A-6-3
O <sub>2</sub> pressure (psia)		3.00	3.00	3.00	3.00	3.00	3.00	3.00
N <sub>2</sub> pressure (psia)		7.00	7.00	7.00	7.00	7.00	7.00	7.00
Specimen length (in)		5.0	5.0	4.9	5.0	4.65	4.5	4.5
Specimen thick. (in)		0.084	0.083	0.089	0.087	0.090	0.072	0.072
Ignition time (sec)		30.	30.	30.	30.	30.	30.	30.
R	Burn time (sec)	34.	35.	37.	42.	31.	32.	32.
	flame-out glow-out	0.	0.	0.	0.	0.	0.	0.
R	Flame color	yellow	yellow	yellow	yellow	yellow	yellow	yellow
E	Smoke	black	black	black	black	black	black	black
	color amount (1)	P	S	S	S	P	S	P
S	Sparkling (1)	N	N	N	N	N	N	N
	Sputtering (1)	N	slight	N	N	slight	N	N
U	Dripping flaming particles (1)	N	slight	N	N	slight	N	N
L	Configuration (2)	Y	Y	N	Y	Y	N	N
	Residue (3) (%)	75.	70.	50.	55.	55.	50.	48.
S	Melted (1)	N	N	slight	slight	slight	N	N
	Color in burn area	black	black	brn/blk	brn/blk	brn/blk	black	black
	exterior interior	black	black	brn/blk	brn/blk	brn/blk	black	black
	Texture in burn area	Y	Y	Y	Y	Y	Y	Y
	powdery crusty (4)	Y	Y	Y	Y	Y	Y	Y
Conclusion (5)		SE 3.5	SE 3.3	SE 4.8	SE 4.5	SE 4.6	SE 3.4	SE 3.7

1. N.....None S.....Some P.....Profuse

2. Generally similar to original specimen: Yes or No.

3. Amount left in (2).

4. Y.....Yes N.....No

5. NC.....Non combustible

SE.....Self-extinguishing in XX inches  
XX

NSE.....Non Self-extinguishing



TABLE 6-57  
ELECTRICAL RESISTANCE  
(Qualitative) (1)

Resistance		Requirements Table II of Appendix A	Specimen No. F-										
			596-1-5	471-3-5	600-1-5	567-1B	563-1B	565-1B	572-1B	570-2A-2	590-6	601-1	590-3B-5
			modified silicone RTV	modified fluorosilicone RTV	epoxy	urethane				epoxy-urethane			
before	min.	---	(3) 0.667	(3) 2.127	(3) 0.087	0.00758	0.00646	0.000834	0.00463	0.40	(3) 0.178	(3) 1.086	(3) 0.521
moisture	max.	---	0.893	2.36	0.185	0.0132	0.0129	0.0086	0.01865	1.667	1.0	2.173	0.694
cycle	ave.	1.	0.763	2.237	0.1292	0.01013	0.00907	0.00576	0.00989	1.232	0.597	1.59	0.651
(x10 <sup>11</sup> ohms)	Pin Pairs		4	4	4	4	4	4	3	4	4	4	4
after	min.	---	6.25	0.0926	1.19					9.26	5.32	8770	7.47
moisture	max.	---	29.4	0.208	1.79	(2)	(2)	(2)	(2)	37.0	454.	20800.	45.5
cycle	ave.	200.	14.65	0.1451	1.49					23.29	199.47	14510.	28.06
(x10 <sup>8</sup> ohms)	Pin Pairs		4	4	4					4	4	4	3

1. See Section 5.6.
2. Specimen decomposed.
3. See Table 7-1.

TABLE 6-58

## ELECTRICAL RESISTANCE TESTS

- Qualitative vs. Quantitative -

No. F-	Formulation	Type	Test Lab.	Electrical Resistance (Ave.) (1)	
				pre-moisture cycle ( $\times 10^{11}$ ohms)	post-moisture cycle ( $\times 10^6$ ohms)
596-1-5	modified silicone RTV	modified silicone RTV	Furane	0.763	14.65
596-1-13,			Delsen	1920.	45. $\times 10^6$
-14, -15					
590-3B-5	epoxy-urethane	epoxy-urethane	Furane	0.651	28.06
590-3A-13			Delsen	14.	1800.

1. Ambient tests.

TABLE 6-59

## EPOXY-URETHANES

EVALUATION OF PROCESSING VARIABLES  
AND ANTI-FOAM AGENTS

Formulation/ Specimen No.	Anti- Foam agent (1)	MEK (2)	Teflon - TFE Covering on Mold	Mold	Specimen Wt. (gm.)	Initial Voids	Observations Final Voids	Other Comments		
570-3-1	N	"shop"	pre- vious- ly used	strip (see Section 5.4)	5.	Y	profuse at base	(7)		
586-1-2	AF-2				5.	Y	"	"		
570-3-3	AF-2 (3)				5.	N	few at base	"		
570-3-4	N	reagent			5.	Y	profuse at base	"		
586-1-5	AF-2				5.	Y	" (-5 <-2)	"		
570-3-6	AF-2 (3)				5.	N	few at base	"		
570-3-7	AF-4 (3)				5.	N	"	"		
570-3-8	N	"shop"	new	5.	Y	profuse at base	"			
570-3-9	N	reagent		5.	Y	"	"			
570-3-10	N	N		5.	Y	"	"			
570-3-11	N	N	N	alum.  cup  (4)	5.	(5)	some throughout	"		
586-1-12	AF-2				5.	Y	profuse at base	"		
570-3-13	N	"shop"			5.	(5)	some throughout	"		
586-1-14	AF-2	5.			Y	" (-14< -12, -16)	"			
570-3-15	N	reagent			5.	(5)	some throughout	"		
586-1-16	AF-2				5.	Y	profuse at base	"		
570-3-17	N	N			N	poly- eth. bag	25.	N	few at top	"
586-1-18	AF-2					25.	Y	"	"	
588-1-19	AF-4		25.	Y		"	"			
588-1-20	AF-4	reagent	new	strip	5.	Y	profuse at base	"		
588-1-21	AF-4		2nd use		5.	?	some (6) throughout	N		

Y..... Yes      N..... No or none

1. Proprietary Furane anti-foam agent added to resin in quantity of 0.1% by weight.

2. Methyl ethyl ketone used to clean mold surfaces.

3. None in resin, but mold dipped in anti-foam agent and oven dried at 150°F.

4. Commercial grade, 2-1/4" dia. disposable cups.

5. Cloudy; voids not visible.

6. Overflowed in vacuum oven.

7. Opaque layer on open surface

TABLE 6-60

## URETHANES

## EVALUATION OF CONTAMINATION BY ANTI-FOAMING AGENTS

(1) (para)	Test	570-3B-17 no anti-foam		586-1B-18 AF-2 (6)		588-1B-19 AF-4 (6)		Requirement (1)
		-NV (2)	-V (3)	-NV (2)	-V (3)	-NV (2)	-V (3)	
3.4.2	Offgassing (5)							
	CO: ( gm/gm)	5.1	6.2	4.8	5.3	5.2	6.6	25., max.
	TO: ( " " )	635.0	435.0	511.0	313.0	676.0	212.0	100., max.
	wt. loss (gms/gm)	0.0017	0.0003	0.0016	0.0004	0.0019	0.0001	---
3.4.4	Vacuum Volatility							
	wt. loss (%)							
	min.	2.2891	1.9643	2.0504	2.0906	1.9309	2.0869	
	max.	2.4862	2.1266	2.1367	2.3934	1.9351	2.2027	
	ave.	2.3877	2.0457	2.0936	2.2420	1.9330	2.1448	1.0
	no. spec.	2	2	2	2	2	2	
	VCM (4) (%)							
	min.	0.1206	0.0527	0.0436	0.0972	0.0550	0.0437	
	max.	0.1455	0.0691	0.0728	0.1556	0.0615	0.0566	
	ave.	0.1331	0.0609	0.0582	0.1264	0.0583	0.0502	0.1
	no. spec.	2	2	2	2	2	2	

1. Appendix A.
2. Tested as is.
3. Specimen preconditioned as follows:
  - a. Eight (8) hours at 150°F under  $10^{-6}$  torr, or less, vacuum.
  - b. Cool the specimen to ambient temperature before removal from the vacuum chamber.
  - c. Expose the specimen to ambient temperature and air for 30 minutes.
4. Volatile Condensable Material.
5. Expressed as pentane equivalents.
6. Proprietary anti-foaming agents (Furane Plastics).

TABLE 7-1  
FINAL SCREENING/PRODUCT CHARACTERIZATION

Component	S	Formulations (pbw)																		
		595	596	593	471-2, -3,-4,-5	604-1	597	598	600	603	571	574	590-2-3	590-4	592	590-5	590-6	599	601	602
Sylgard 186	1	100.	(3)						(4)	(4)									(5)	(5)
Phox-Chek P/30	2	50.																		
Glass Frit 7570 (1)	3	25.																		
RTV 94-531	5			100.																
Dechlorane 604 (2)	4			150.																
D.E.R. 741	22						100.													
ERX-67	23						75.						100.	23.		23.	100.	100		
Brominex 160P	38										100.	100.	274.25	44.05	100.		548.5	548.5		
PAP1 901	41												134.7	31.27		30.96	134.7		135.5	135.5
F-595-1	6		175.																	
F-593-1	6			250.																
F-593-2	6					250.														
F-597-1	6							175.												
F-597-2	6								175.											
F-598-1	6							18.08	18.08											
F-574-1	6												274.94	36.58						
F-571-1	6													45.87						
F-592-1	6														126.5					
F-599-1	6																	649.05		
F-599-2	6																		592.13	
Stannous octoate	42									0.15	0.25				0.125		0.69	0.55		
Sylgard 186 C.A.	1		10.																	
RTV 94-531 C.A.	5			10.		10.														
D.E.H. 61	22						16.79													
DETA	30						1.29													

S.....Source (See Table 6-2)  
1. 325 mesh, predried at 212°F.  
2. As received.

3. Same final formulation as F-476.  
4. Same final formulation as F-537.  
5. Same final formulation as F-590.

TABLE 7-2  
FINAL SCREENING/PRODUCT CHARACTERIZATION

- Formulations Processing -

Formulation No. F-	Steps							
	(°F)	(1) (hr./min.)	(°F)	(2) (hr./min.)	(°F)	(3) (hr./min.)	(°F)	(4) (hr./min.)
595-1	74.	-/30	74.	4/-	---	---	---	---
596-1	73.	-/35	73.	1/15	150.	15/45	---	---
-2	76.	-/30	74.	1/20	"	18/30	---	---
-3	80.	-/5	77.	2/30	"	18/-	---	---
-4	80.	-/15	80.	1/30	"	2/5	150.	11/-
-5	83.	-/5	84.	2/30	"	11/-	"	9/40
471-2	90.	-/45	90.	1/15	"	2/35	"	13/40
-3	83.	-/15	83.	-/45	"	13/15	"	1/45
-4	82.	-/15	82.	-/45	"	2/-	"	12/10
-5	71.	-/5	71.	1/-	"	2/40	"	14/-
593-1	90.	2/-	90.	6/-	---	---	---	---
-2	92.	1/45	92.	7/-	---	---	---	---
604-1	74.	-/15	74.	4/-	150.	2/-	150.	12/-
597-1	87.	-/20	---	---	---	---	---	---
-2	76.	-/5	76.	5/15	---	---	---	---
598-1	87.	-/10	---	---	---	---	---	---
600-1	85.	-/15	85.	-/55	150.	12/30	---	---
-2A	78.	-/15	78.	-/45	"	9/30	---	---
-2B	78.	-/15	78.	-/45	R.T.	50/30	150.	16/30
-3A	75.	-/5	75.	-/40	150.	17/30	---	---
-3B	75.	-/5	75.	-/40	R.T.	5d./15 hrs.	150.	24/15
603-1A	79.	-/5	79.	-/30	150.	15/15	---	---
-1B	79.	-/5	79.	-/30	150.	15/15	150.	26/50
-2	75.	-/5	75.	-/20	150.	17/-	---	---
571-1	75.	-/4	---	---	---	---	---	---
574-1	77.	-/3	---	---	---	---	---	---
592-1	70.	-/5	70.	1/30	---	---	---	---
590-3A	84.	-/4	84.	-/5	150.	17/-	---	---
-3B	84.	-/4	84.	-/5	150.	16/15	---	---
-4	73.	-/4	73.	-/15	150.	42/30	---	---
-5	73.	-/4	73.	-/30	150.	43/30	---	---
-6	73.	-/4	73.	1/30	150.	10/45	150.	58/35

TABLE 7-2 (cont)

## FINAL SCREENING/PRODUCT CHARACTERIZATION

## - Formulations Processing

Formulation No. F-	Steps							
	(°F)	(1) (hr./min.)	(°F)	(2) (hr./min.)	(°F)	(3) (hr./min.)	(°F)	(4) (hr./min.)
599-1	83.	-/15	78.-86.	~24/-	---	---	---	---
-2	85.	-/15	85.	2/-	---	---	---	---
601-1	81.	-/15	81.	1/-	150.	12/-	150.	30/15
-2A	76.	-/7	78.	2/45	150.	16/15	150.	25/5
-2B	76.	-/7	78.	2/45	R.T.	7d./16 hrs.	150.	50/30
-3A	83.	-/13	84.	3/-	150.	51/45	---	---
-3B	83.	-/13	84.	3/-	R.T.	4d./3 hrs.	150.	57/45
-4	73.	-/5	~74.	28/-	150.	37/45	150.	12/30
602-1A	81.	-/5	81.	8/-	150.	~60/-	---	---
-1B	81.	-/5	81.	8/-	150.	~52/-	---	---
-2	75.	-/5	75.	~20/- (5)	150.	15/-	---	---
-3A	74.	-/5	74.	10/-	150.	29/-	150.	20/20
-3B	74.	-/5	74.	10/-	150.	29/-	150.	9 days

1. Blend at \_\_\_\_\_ °F for \_\_\_\_\_ hr./min.
2. Degas at \_\_\_\_\_ °F for \_\_\_\_\_ hr./min. under 29. in. mercury vacuum.
3. Cure at \_\_\_\_\_ °F. for \_\_\_\_\_ hr./min.
4. Post cure at \_\_\_\_\_ °F for \_\_\_\_\_ hr./min.
5. Partially gelled.

TABLE 7- 3  
FINAL SCREENING/PRODUCT CHARACTERIZATION

- Specimen Disposition -

Test	Reference Para.		Material				Specimen No. F-
	App. A	Ref. 7-1	S (1)	FS (2)	E (3)	E-U (4)	
Dielectric Constant and Power Factor		4.4.3.1	X				596-1-21 596-2-22 596-2-24 596-3-25 596-3-23/26
Volume and Surface Resistivity	3.4.5.1/.2	4.4.3.3		X			604-1-21/24 604-1-22/25 604-1-23/26
					X		600-1-21 600-2B-22 600-2B-24 603-1B-23/26 603-1B-25
						X	596-3B-21 601-2A-22 601-2B-23 601-2A-24 601-2B-25 601-3B-26
Arc Resistance		4.4.3.4				X	
Dielectric Strength	3.4.5.1/.2	4.4.3.2	X				596-2-27 596-3-28 596-4-29 596-4-30 596-4-31
				X			471-3-27 471-3-28 471-5-31 604-1-29 604-1-30
					X		600-2B-27 603-1B-29 603-1B-30 603-2-28 603-2-31
						X	601-3B-27 601-3B-28 602-1B-29 602-1B-30 602-1B-31



TABLE 7-3 (cont)  
FINAL SCREENING/PRODUCT CHARACTERIZATION  
- Specimen Disposition -

Test	Reference Para.		Material				Specimen No. F-
	App. A	Ref. 7-1	S (1)	FS (2)	E (3)	E-U (4)	
Insulation Resistance  a) ambient/ 212°F	3.4.5.1/.2	4.4.3.5	X				596-4-16 596-4-17 596-4-18
							471-2-16 471-2-17 471-3-18
							600-3A-16 603-1A-17 603-1A-18
							601-3A-16 601-3A-17 601-3A-18
b) moisture cycle	3.4.5.1/.2	4.4.3.11	X				596-1-13 596-3-14 596-3-15
							604-1-13 604-1-14 604-1-15
							600-2A-13 600-3A-14 600-3A-15
							590-3B-13 601-4-15 602-1A-14
c) rpr./ moisture cycle	3.4.5.3	4.4.3.11	X				596-1-7 596-1-7/-10 596-2-8/ 596-2-8/-11 596-2-9 596-2-9/-12
							471-3-7 471-3-7/-10 471-4-8 471-4-8/-11 471-4-9 471-4-9/-12

TABLE 7-3 (cont)  
FINAL SCREENING/PRODUCT CHARACTERIZATION  
- Specimen Disposition -

Test	Reference Para.		Material				Specimen No. F-
	App. A	Ref. 7-1	S (1)	FS (2)	E (3)	E-U (4)	
			X				600-1-7 600-1-7/-10 600-2A-8 600-2A-8/-11 600-2A-9 600-2A-9/-12
			X				601-2A-7 601-2A-7/-10 601-2A-8 601-2A-8/-11 601-2A-9 601-2A-9/-12
d) vacuum/ moisture cycle	3.4.4	---	X	X	X	X	596-2-2 471-3-2 600-1-2 602-1A-2
Tear Strength	3.4.5.1/.2	4.4.3.10 4.4.3.12	X				596-1-19/20
				X			471-2-19/20
Tensile Strength and Elongation	3.4.5.1/.2	4.4.3.10 4.4.3.12			X		600-1-19/20 600-3B-19
						X	590-2A-6/19 590-4-19/20
Shrinkage	Table II	---	X				596-3-15
				X			604-1-15
					X		600-3A-15
						X	590-3B-13
Hardness	Table II	---	X				596-1-19/20
				X			471-2-19/20
					X		600-1 600-2B 600-3B 603-1B
						X	590-3B-21 590-4-19/20

TABLE 7-3 (cont)

## FINAL SCREENING/PRODUCT CHARACTERIZATION

- Specimen Disposition -

Test	Reference Para.		Material				Specimen No. F-
	App. A	Ref. 7-1	S (1)	FS (2)	E (3)	E-U (4)	
Viscosity	Table II	---	X				595-1 596-4
				X			593-2 604-1
					X		597-2 603-1
						X	599-2 602-1
Specific Gravity	Table II	---	X				596-3-23/26
				X			604-1-21/24
					X		603-1B-23/26
						X	601-2A-22
Aging	3.4.5.4	---	X				596-1-1
Oxygen Impact	3.4.6	---		X			471-2-1
					X		600-1-1
						X	590-3B-1
Flammability	3.4.1	---	X				596-2-3
				X			471-3-3
					X		600-2B-3
						X	590-6-3 602-1B-3
Offgassing	3.4.2	---	X				596-1-4B
Odor	3.4.3	---		X			471-2-4B
					X		600-1-4B/1 600-1-4B/2
Vacuum Volatility	3.4.4	---				X	590-5-4B

1. Modified silicone RTV.
2. Modified fluorosilicone RTV.
3. Epoxy.
4. Epoxy-urethane.

TABLE 7-4  
FORMULATION PROPERTIES

- Modified Silicone RTV -

Property	T/M (1)	Compound Requirement (6)	Value			No. of Specimens Per Value	Thickness (in)			Comments
			Min.	Max.	Ave.		Min.	Max.	Ave.	
Dielectric Constant	M	5.0, max.	4.8	5.1	5.0	3	0.122	0.124	0.123	
Power Factor	M	0.09, max.	0.09	0.12	0.11	3	0.122	0.124	0.123	
Dielectric Strength (v/mil)	M	350., min.	220.	260.	240.	5	0.040	0.059	0.051	
Volume Resistivity (ambient) ( $\times 10^{12}$ ohms-cm)	M	(P) 1., min. (C) 1., min.	1200.	1400.	1300.	3	0.122	0.124	0.123	
Surface Resistivity ( $\times 10^{12}$ ohms)	M	1., min.	28000.	>56000.	>47000.	3	0.122	0.124	0.123	
Arc Resistance (seconds)	T	45., min. (2)	125.	128.	127.	3	0.118	0.127	0.123	continuous burning
Insulation Resistance (megohms) ambient ( $\times 10^5$ ) 212°F	M	(3) 1., min. 750., min.	1670. 9.6x10 <sup>6</sup>	4500. 9.9x10 <sup>6</sup>	2720. 9.7x10 <sup>6</sup>	3 3	--	--	(7)	
pre-m.c. (4)/ambient ( $\times 10^5$ )		1., min.	1880.	2000.	1920.	3				
m.c. (4)/ambient		200., min.	1.x10 <sup>6</sup>	80.x10 <sup>6</sup>	45.x10 <sup>6</sup>	3				
m.c. (4)/212°F		200., min.	0.6x10 <sup>6</sup>	6.9x10 <sup>6</sup>	3.9x10 <sup>6</sup>	3				
pre-rprd./ambient ( $\times 10^5$ )		1., min.	1580.	1880.	1740.	3				
rprd./m.c. (4)/ambient		200., min.	1.3x10 <sup>3</sup>	2.7x10 <sup>3</sup>	2.0x10 <sup>3</sup>	3				
rprd./m.c. (4)/212°F		200., min.	530.	730.	610.	3				
pre-vac./ambient ( $\times 10^5$ )		1., min.	300.	2000.	1300.	1				
vac. (5) ( $\times 10^5$ )		---	1000.	2000.	1400.	1				
vac. (5)/m.c. (4)/ambient		200., min.	31.	5000.	1900.	1				
vac. (5)/m.c. (4)/212°F.		200., min.	4.2	6.3x10 <sup>6</sup>	1.5x10 <sup>6</sup>	1				
Tear Strength (lb/in)	M T	15., min. 25., min.	50.	60.	58.	5	0.077	0.080	0.079	
Tensile Strength (psi)	T	350., min.	360.	450.	396.	5	0.079	0.081	0.080	
Elongation (%)	T	125., min.	370.	400.	380.	5	0.079	0.081	0.080	
Shrinkage (%)	M	1., max. (opaque) 3., max. (clear)	--	--	<1.	3	--	--	(7)	
Hardness (after full cure)	M	30.-85. (Shore A)	57.	59.	58.	1	--	--	0.080	5 points
Clarity	T	Water clear	o	p	a	q	u	e	--	
Viscosity, 77°F (poises) (catalyzed)	T	100. to 6,000.	--	--	2520.	1	--	--	--	
Specific Gravity	T	1.25 max.,	--	--	1.40	1	--	--	0.125	

1. T.....Target Value M.....Mandatory Value
2. Based on average value out of 5 for each specimen.
3. Based on average value out of 4 for each specimen.
4. Moisture cycle (m.c.): 75-160°F/95% R.H./1 day per cycle/5 days.

5. Vacuum (vac):  $1 \times 10^{-6}$  torr/150°F/24 hrs.
6. Statement of Work, NAS 9-11068.
7. 1."x1."x2." block.

TABLE 7-5

## FORMULATION PROPERTIES

- Modified Fluorosilicone RTV -

Property	T/M (1)	Compound Requirement (6)	Value			No. of Specimens Per Value	Thickness (in)			Comments
			Min.	Max.	Ave.		Min.	Max.	Ave.	
Dielectric Constant	M	5.0, max.	5.2	5.3	5.3	3	0.144	0.158	0.153	
Power Factor	M	0.09, max.	0.020	0.020	0.020	3	0.144	0.158	0.153	
Dielectric Strength (v/mil)	M	350., min.	280.	400.	350.	5	0.034	0.056	0.047	
Volume Resistivity (ambient) ( $\times 10^{12}$ ohms-cm)	M	(P) 1., min. (C) 1., min.	4.2	4.8	4.5	3	0.144	0.158	0.153	
Surface Resistivity ( $\times 10^{12}$ ohms)	M	1., min.	11.	47.	16.	3	0.144	0.158	0.153	
Arc Resistance (seconds)	T	45., min. (2)	4.	5.	4.3	3	0.140	0.158	0.154	tracked
Insulation Resistance (megohms) ambient ( $\times 10^5$ ) 212°F	M	(3) 1., min. 750., min.	3.3 1900.	4.0 2700.	3.6 2300.	3 3	--	--	(7)	
pre-m.c. (4)/ambient ( $\times 10^5$ )		1., min.	4.4	4.6	4.5	3				
m.c. (4)/ambient		200., min.	73. $\times 10^3$	86. $\times 10^3$	78. $\times 10^3$	3				
m.c. (4)/212°F		200., min.	1000.	1300.	1100.	3				
pre-rprd./ambient ( $\times 10^5$ )		1., min.	3.7	4.6	4.1	3				
rprd./m.c. (4)/ambient		200., min.	48. $\times 10^3$	51. $\times 10^3$	49. $\times 10^3$	3				
rprd./m.c. (4)/212°F		200., min.	620.	650.	623.	3				
pre-vac./ambient ( $\times 10^5$ )		1., min.	2.2	2.4	2.3	1				
vac. (5) ( $\times 10^5$ )		--	5.7	16.	7.8	1				
vac. (5)/m.c. (4)/ambient		200., min.	59. $\times 10^3$	81. $\times 10^3$	73. $\times 10^3$	1				
vac. (5)/m.c. (4)/212°F		200., min.	580.	820.	740.	1				
Tear Strength (lb/in)	M T	15., min. 25., min.	14.	20.	16.	5	0.092	0.098	0.093	
Tensile Strength (psi)	T	350., min.	90.	160.	130.	5	0.088	0.098	0.092	
Elongation (%)	T	125., min.	80.	130.	118.	5	0.088	0.098	0.092	
Shrinkage (%)	M	1., max. (opaque) 3., max. (clear)	--	--	<1.	3	--	--	(7)	
Hardness (after full cure)	M	30.-85. (Shore A)	72.	75.	74.	1	--	--	0.095	5 points
Clarity	T	Water clear	o p a q u e				--	0.088	0.125	--
Viscosity, 77°F (poises) (catalyzed)	T	100. to 6,000.	--	--	5460.	1	--	--	--	
Specific Gravity	T	1.25., max.	--	--	1.77	1	--	--	0.155	

1. T.....Target Value M.....Mandatory Value.

2. Based on average value out of 5 for each specimen.

3. Based on average value out of 4 for each specimen.

4. Moisture cycle (m.c.): 75-160°F/95% R.H./1 day per cycle/5 days.

5. Vacuum (vac):  $1 \times 10^{-6}$  torr/150°F/24 hrs.

6. Statement of Work, NAS 9-11068.

7. 1."x1."x2." block.

TABLE 7-6  
FORMULATION PROPERTIES

- Epoxy -

Property	T/M (1)	Compound Requirement (6)	Min.	Value Max.	Ave.	No. of Specimens Per Value	Thickness (in)			Comments
							Min.	Max.	Ave.	
Dielectric Constant	M	5.0, max.	4.6	4.9	4.7	3	0.122	0.125	0.123	
Power Factor	M	0.09, max.	0.083	0.088	0.086	3	0.122	0.125	0.123	
Dielectric Strength (v/mil)	M	350., min.	500.	620.	550.	5	0.042	0.056	0.050	
Volume Resistivity (ambient) ( $\times 10^{12}$ ohms-cm)	M	(P) 1., min. (C) 1., min.	0.057	0.083	0.074	3	0.122	0.127	0.125	
Surface Resistivity ( $\times 10^{12}$ ohms)	M	1., min.	0.041	0.049	0.046	3	0.122	0.127	0.125	
Arc Resistance (seconds)	T	45., min. (2)	44.	62.	53.	3	0.120	0.125	0.122	melting and burning
Insulation Resistance (megohms) ambient ( $\times 10^5$ ) 212°F	M	(3) 1., min. 750., min.	0.16 1.5	0.22 2.8	0.18 2.3	3 3	--	--	(7)	
pre-m.c. (4)/ambient ( $\times 10^5$ )		1., min.	0.075	0.15	0.125	3				
m.c. (4)/ambient		200., min.	17.	34.	27.	3				
m.c. (4)/212°F.		200., min.	0.12	0.19	0.15	3				
pre-rprd./ambient ( $\times 10^5$ )		1., min.	0.29	0.38	0.34	3				
rprd./m.c. (4)/ambient		200., min.	15.	19.	17.	3				
rprd./m.c. (4)/212°F		200., min.	0.12	0.20	0.16	3				
pre-vac./ambient ( $\times 10^5$ )		1., min.	0.042	0.062	0.051	1				
vac. (5) ( $\times 10^5$ )		--	0.041	0.050	0.044	1				
vac. (5)/m.c. (4)/ambient		200., min.	7.8	16.	11.					
vac. (5)/m.c. (4)/212°F		200., min.	0.093	0.11	0.10	1				
Tear Strength (lb/in)	M T	15., min. 25., min.	51.	140.	70.	5	0.070	0.081	0.078	
Tensile Strength (psi)	T	350., min.	340.	1330.	604.	5	0.070	0.080	0.077	
Elongation (%)	T	125., min.	230.	300.	290.	5	0.070	0.080	0.077	
Shrinkage (%)	M	1., max. (opaque) 3., max. (clear)	--	--	<3.	3	--	--	(7)	
Hardness (after full cure)	M	30.-85. (Shore A)	65.	79.	74.	4	0.053	0.078	--	12 points
Clarity	T	Water clear	--	--	(8)	--	0.042	0.127	--	
Viscosity, 77°F (poises) (catalyzed)	T	100. to 6,000.	--	--	5.76	1	--	--	--	
Specific Gravity	T	1.25, max.	--	--	1.37	1	--	--	0.125	

1. T, . . . . Target Value M, . . . . Mandatory Value.

2. Based on average value out of 5 for each specimen.

3. Based on average value out of 4 for each specimen.

5. Moisture cycle (m.c.): 75-160°F/95% R.H./1 day per cycle/5 days.

5. Vacuum (vac):  $1 \times 10^{-6}$  torr/150°F/24 hrs.

6. Statement of Work, NAS 9-11068.

7. 1."x1."x2." block.

8. Transparent/pale yellow.

TABLE 7-7  
FORMULATION PROPERTIES

- Epoxy-Urethane -

Property	T/M (1)	Compound Requirement (6)	Value			No. of Specimens Per Value	Thickness (in)			Comments
			Min.	Max.	Ave.		Min.	Max.	Ave.	
Dielectric Constant	M	5.0., max.	4.1	4.1	4.1	3	0.122	0.124	0.123	
Power Factor	M	0.09, max.	0.051	0.053	0.052	3	0.122	0.124	0.123	
Dielectric Strength (v/mil)	M	350., min.	570.	700.	610.	5	0.043	0.052	0.048	
Volume Resistivity (ambient) ( $\times 10^{12}$ ohms-cm)	M	(P) 1., min. (C) 1., min.	34.	40.	38.	3	0.122	0.124	0.123	
Surface Resistivity ( $\times 10^{12}$ ohms)	M	1., min.	180.	340.	240.	3	0.122	0.124	0.123	
Arc Resistance (seconds)	T	45., min. (2)	23.	28.	25.	3	0.119	0.124	0.122	tracked
Insulation Resistance (megohms) ambient ( $\times 10^5$ ) 212°F	M	(3) 1., min. 750., min.	1.6 160.	2.0 220.	1.8 190.	3 3	--	--	(7)	
pre-m.c. (4)/ambient ( $\times 10^5$ )		1., min.	9.	26.	16.	3				
m.c. (4)/ambient		200., min.	1.5 $\times 10^3$	3.5 $\times 10^3$	2.3 $\times 10^3$	3				
m.c. (4)/212°F		200., min.	3.7	7.5	6.2	3				
pre-rprd./ambient ( $\times 10^5$ )		1., min.	12.	28.	19.	3				
rprd./m.c. (4)/ambient		200., min.	780.	1500.	1020.	3				
rprd./m.c. (4)/212°F		200., min.	3.5	4.1	3.8	3				
pre-vac./ambient ( $\times 10^5$ )		1., min.	75.	1600.	1300.	1				
vac. (5) ( $\times 10^5$ )		--	(9)	(9)	(9)	1				
vac. (5)/m.c. (4)/ambient		200., min.	(9)	(9)	(9)	1				
vac. (5)/m.c. (4)/212°F		200., min.	(9)	(9)	(9)	1				
Tear Strength (lb/in)	M T	15., min. 25., min.	120.	130.	128.	5	0.070	0.071	0.071	
Tensile Strength (psi)	T	350., min.	1600.	1860.	1725.	4	0.070	0.070	0.070	
Elongation (%)	T	125., min.	130.	140.	135.	4	0.070	0.070	0.070	
Shrinkage (%)	M	1., max. (opaque) 3., max. (clear)	--	--	(3)	3	--	--	(7)	
Hardness (after full cure)	M	30.-85. (Shore A)	83.	90.	86.	2	0.070	0.124	--	10 points
Clarity	T	Water clear	--	--	(8)	--	0.043	0.124	--	
Viscosity, 77°F (poises) (catalyzed)	T	100. to 6,000.	--	--	70.	1	--	--	--	
Specific Gravity	T	1.25, max.	--	--	1.44	1	--	--	0.125	

1. T.....Target Value M.....Mandatory Value.
2. Based on average value out of 5 for each specimen.
3. Based on average value out of 4 for each specimen.
4. Moisture cycle (m.c.): 75-160°F/95% R.H./1 day per cycle/5 days.

5. Vacuum (vac):  $1 \times 10^{-6}$  torr/150°F/24 hrs.
6. Statement of Work, NAS 9-11068.
7. 1." x 1." x 2." block.
8. Transparent/brown.
9. A malfunction in a temperature controller caused the destruction of the specimen during the vacuum exposure.

TABLE 7-8  
HARDNESS (1)

Type	Material	F-	Thickness (in.)	Readings (no.)	Durometer (Shore A-2)		
					Min.	Max.	Ave.
	Modified silicone RTV	596-1-19/20	0.030	5	57.	59.	58.
	Modified fluorosilicone RTV	471-2-19/20	0.075	5	72.	75.	74.
	Epoxy	600-1	0.078	3	62.	72.	65.
		600-2	0.075	3	75.	76.	75.
		600-3	0.055	3	78.	80.	79.
		603-1	0.053	3	70.	80.	77.
		consensus		12	62.	80.	74.
	Epoxy-Urethane	590-4-19/20	0.070	5	85.	90.	88 (2)
				5	68.	72.	70. (3)
		590-3-21	0.124	5	83.	84.	84. (2)
		consensus		10	83.	90.	86. (2)

1. Requirement: 30.-85. (Shore A).
2. Initial reading.
3. Readings 25 sec. later.



TABLE 7-9

## VISCOSITY

Material Type	F-	state	T/M (1)	Requirement	Test Conditions (2)		spindle (no.)	speed (rpm)	temp. (°F)	Viscosity (Poise)
				value (Poise)	volume (ml.) beaker	mat'l.				
Modified Silicone RTV	595-1	uncat.	(3)	--	600.	450.	6	1.	81.5	5200.
				--	"	"	6	2.5	"	3644.
"	596-4	catalyzed	T	100.-	"	210. (4)	6	1.	80.5	2520.
				6000.	"	210. (4)	6	2.5	80.5	1816.
Modified Fluorosilicone RTV	593-2	uncat.	(3)	--	"	450.	6	1.	80.	6210.
"	604-1	catalyzed	T	100.-	"	"	6	1.	77.5	5460.
Epoxy	597-2	uncat.	(3)	--	"	"	3	10.	78.5	19.70
					"	"	3	20.	"	19.85
					"	"	3	50.	"	19.82
"	603-1	catalyzed	T	100.-	"	325. (5)	3	10.	76.5	6.00
				6000.	"	" "	3	20.	"	5.70
					"	" "	3	50.	"	5.76
Epoxy- Urethane	599-2	uncat.	(3)	--	"	450.	5	10.		185.2
"	602-1	catalyzed	T	100.-	"	325. (5)	5	10.	79.	69.2
				6000.	"	" "	5	20.	"	69.2
					"	" "	5	50.	"	70.48

1. T.....Target value      M.....Mandatory Value

2. Brookfield Model RVT Viscosimeter.

3. Test not required by statement of work.

4. No guard, level: 3/4" below spindle notch.

5. 1/4" below spindle notch.

TABLE 7-10  
FORMULATIONS PROPERTIES  
- Summary -

Property	T/M (6)	Compound Requirement (7)	See Table	Modified Silicone RTV			Modified Fluorosilicone RTV			Min.	Epoxy		Epoxy-Urethane		
				Min.	Max.	Ave.	Min.	Max.	Ave.		Max.	Ave.	Min.	Max.	Ave.
Dielectric Constant	M	5.0, max.		4.8	5.1	5.0	5.2	5.3	5.3	4.6	4.9	4.7	4.1	4.1	4.1
Power Factor	M	0.09, max.		0.09	0.12	0.11	0.020	0.020	0.020	0.083	0.088	0.086	0.051	0.053	0.052
Dielectric Strength (v/mil) (1)	M	350., min.		220.	260.	240.	280.	400.	350.	500.	620.	550.	570.	700.	610.
Volume Resistivity (ambient) ( $\times 10^{12}$ ohms-cm)	M	(P) 1., min. (C) 1., min.		1200.	1400.	1300.	4.2	4.8	4.5	0.057	0.083	0.074	34.	40.	38.
Surface Resistivity ( $\times 10^{12}$ ohms)	M	1., min.		28000.	>56000.	>47000.	11.	47.	16.	0.041	0.049	0.046	180.	340.	240.
Arc Resistance (seconds)	T	45., min. (2)		125.	128.	127.	4.	5.	4.3	44.	62.	53.	23.	28.	25.
Insulation Resistance (megohms) ambient ( $\times 10^5$ ) 212°F	M	(3) 1., min. 750., min.		1670. 9.6 $\times 10^6$	4500. 9.9 $\times 10^6$	2720. 9.7 $\times 10^6$	3.3 1900.	4.0 2700.	3.6 2300.	0.16 1.5	0.22 2.8	0.18 2.3	1.6 160.	2.0 220.	1.8 190.
pre-m.c. (4)/ambient ( $\times 10^5$ ) m.c. (4)/ambient m.c. (4)/212°F		1., min. 200., min. 200., min.		1880. 1.1 $\times 10^6$ 0.6 $\times 10^6$	2000. 80.1 $\times 10^6$ 6.9 $\times 10^6$	1920. 45.1 $\times 10^6$ 3.9 $\times 10^6$	4.4 73.1 $\times 10^3$ 1000.	4.6 86.1 $\times 10^3$ 1300.	4.5 78.1 $\times 10^3$ 1100.	0.075 17. 0.12	0.15 34. 0.19	0.125 27. 0.15	9. 1.5 $\times 10^3$ 3.7	26. 3.5 $\times 10^3$ 7.5	16. 2.3 $\times 10^3$ 6.2
pre-rprd./ambient ( $\times 10^5$ ) rprd./m.c. (4)/ambient rprd./m.c. (4)/212°F		1., min. 200., min. 200., min.		1580. 1.3 $\times 10^3$ 530.	1880. 2.7 $\times 10^3$ 730.	1740. 2.0 $\times 10^3$ 610.	3.7 48.1 $\times 10^3$ 620.	4.6 51.1 $\times 10^3$ 630.	4.1 49.1 $\times 10^3$ 623.	0.29 15. 0.12	0.38 19. 0.20	0.34 17. 0.16	12. 780. 3.5	28. 1500. 4.1	19. 1020. 3.8
pre-vac./ambient ( $\times 10^5$ ) vac. (5) ( $\times 10^5$ ) vac. (5)/m.c. (4)/ambient vac. (5)/m.c. (4)/212°F		1., min. --- 200., min. 200., min.		300. 1000. 31. 4.2	2000. 2000. 5000. 6.3 $\times 10^6$	1300. 1400. 1900. 1.5 $\times 10^6$	2.2 5.7 59.1 $\times 10^3$ 580.	2.4 16. 81.1 $\times 10^3$ 820.	2.3 7.8 73.1 $\times 10^3$ 740.	0.042 0.041 7.8 0.093	0.062 0.050 16. 0.11	0.051 0.044 11. 0.10	75. (11) (11) (11)	1600. (11) (11) (11)	1300. (11) (11) (11)
Tear Strength (lb/in)	M T	15., min. 25., min.		50.	60.	58.	14.	20.	16.	51.	140.	70.	120.	130.	128.
Tensile Strength (psi)	T	350., min.		360.	450.	396.	90.	160.	130.	340.	1330.	604.	1600.(8)	1860.(8)	1725.(8)
Elongation (%)	T	125., min.		370.	400.	380.	80.	130.	118.	230.	300.	290.	130.(8)	140.(8)	135.(8)
Shrinkage (%)	M	1., max. (opaque) 3., max. (clear)		--	--	<1.	--	--	<1.	--	--	<3.	--	--	<3.
Hardness (after full cure)	M	30.-85. (Shore A)		57.	59.	58.	72.	75.	74.	65.	79.	74.	83.	90.	86.
Clarity	T	Water clear		o p a q u e			o p a q u e			--	--	(9)	--	--	(10)
Viscosity, 77°F (poises) (catalyzed)	T	100. to 6,000.		--	--	2520.	--	--	5460.	--	--	5.76	--	--	70.
Specific Gravity	T	1.25, max.		--	--	1.40	--	--	1.77	--	--	1.37	--	--	1.44

1. 34-59 mils thick.

2. Based on average value out of 5 for each specimen.

3. Based on average value out of 4 for each specimen.

4. Moisture cycle (m.c.): 75-160°F/95% R.H./1 day per cycle/5 days.

5. Vacuum (vac):  $1 \times 10^{-6}$  torr/150°F/24 hrs.

6. T.....Target Value M.....Mandatory Value.

7. S: Statement of Work, NAS 9-11068.

8. 10 or specimens.

9. Transparent/pale yellow.

10. Transparent/brown.

11. A malfunction in a temperature controller caused the destruction of the specimen during the vacuum exposure.

TABLE 7-11  
FORMULATIONS PROPERTIES  
- Comparison With Previous R&D Efforts -  
(Silicone RTV Based)

Property	T/M (6)	Compound Requirement (7)	See Table	NAS 9-11068 Modified Silicone RTV			NAS 9-8750 NASA - MSC - SG-12K1 (Ref. 3-7)		
				Min.	Max.	Ave.	Min.	Max.	Ave.
Dielectric Constant	M	5.0, max.		4.8	5.1	5.0	6.6	6.7	6.7
Power Factor	M	0.09, max.		0.09	0.12	0.11	0.003	0.008	0.005
Dielectric Strength (v/mil) (1)	M	350., min.		220.	260.	240.	260.	310.	290.
Volume Resistivity (ambient) ( $\times 10^{12}$ ohms-cm)	M	(P) 1., min. (C) 1., min.		1200.	1400.	1300.	0.062	0.55	0.30
Surface Resistivity ( $\times 10^{12}$ ohms)	M	1., min.		28000.	>56000.	>47000.	5.	22.	15.
Arc Resistance (seconds)	T	45., min. (2)		125.	128.	127.	122.	124.	123.
Insulation Resistance (megohms) ambient ( $\times 10^5$ ) 212°F	M	(3) 1., min. 750., min.		1670. 9.6 $\times 10^6$	4500. 9.9 $\times 10^6$	2720. 9.7 $\times 10^6$	21. 4.8 $\times 10^6$	660. 6.9 $\times 10^6$	330. 6.0 $\times 10^6$
pre-m.c. (4)/ambient ( $\times 10^5$ )		1., min.		1880.	2000.	1920.	--	--	--
m.c. (4)/ambient		200., min.		1.1 $\times 10^6$	80.1 $\times 10^6$	45.1 $\times 10^6$	1.9	27.	10.
m.c. (4)/212°F		200., min.		0.6 $\times 10^6$	6.9 $\times 10^6$	3.9 $\times 10^6$	0.44	0.78	0.55
pre-rprd./ambient ( $\times 10^5$ )		1., min.		1580.	1880.	1740.	--	--	--
rprd./m.c. (4)/ambient		200., min.		1.3 $\times 10^3$	2.7 $\times 10^3$	2.0 $\times 10^3$	0.095	0.39	0.23
rprd./m.c. (4)/212°F.		200., min.		530.	730.	610.	0.025	0.057	0.039
pre-vac./ambient ( $\times 10^5$ )		1., min.		300.	2000.	1300.	--	--	--
vac. (5)/m.c. (4)/ambient		200., min.		31.	5000.	1900.	0.037	1.8	0.76
vac. (5)/m.c. (4)/212°F.		200., min.		4.2	6.3 $\times 10^6$	1.5 $\times 10^6$	0.01	0.22	0.10
Tear Strength (lb/in)	M T	15., min. 25., min.		50.	60.	58.	32.	37.	35.
Tensile Strength (psi)	T	350., min.		360.	450.	396.	250.	260.	260.
Elongation (%)	T	125., min.		370.	400.	380.	310.	330.	318.
Shrinkage (%)	M	1., max. (opaque) 3., max. (clear)		--	--	<1.	--	--	nil
Hardness (after full cure)	M	30.-85. (Shore A)		57.	59.	58.	64.	68.	66.
Clarity	T	Water clear		o p a q u e			o p a q u e		
Viscosity, 77°F (poises) (catalyzed)	T	100. to 6,000.		--	--	2520.	--	--	2340.
Specific Gravity	T	1.25, max.		--	--	1.40	1.55	1.61	1.58

1. 34-59 mils thick.
2. Based on average value out of 5 for each specimen.
3. Based on average value out of 4 for each specimen.
4. Moisture cycle (m.c.): 75-160°F/95% R.H./1 day per cycle/5 days.
5. Vacuum (vac): NAS 9-8750:  $1 \times 10^{-4}$  torr/ambient temp./24 hrs.;  
NAS 9-11068:  $1 \times 10^{-6}$  torr/150°F/24 hrs.

6. T.....Target Value M.....Mandatory Value.
7. Statement of Work, NAS 9-11068.

TABLE 7-12

## FORMULATIONS PROPERTIES

- Comparison With Previous R&D Efforts -  
(Fluorosilicone RTV Based)

Property	T/M (6)	Compound Requirement (7)	See Table	NAS 9-11068 Modified Fluorosilicone RTV			NAS 9-8750 (Ref. 3-7) F-387		
				Min.	Max.	Ave.	Min.	Max.	Ave.
Dielectric Constant	M	5.0., max.		5.2	5.3	5.3	4.7	4.8	4.7
Power Factor	M	0.09, max.		0.020	0.020	0.020	0.020	0.021	0.020
Dielectric Strength (v/mil) (1)	M	350., min.		280.	400.	350.	340.	390.	370.
Volume Resistivity (ambient) ( $\times 10^{12}$ ohms-cm)	M	(P) 1., min. (C) 1., min.		4.2	4.8	4.5	19.	30.	24.
Surface Resistivity ( $\times 10^{12}$ ohms)	M	1., min.		11.	47.	16.	230.	720.	390.
Arc Resistance (seconds)	T	45., min. (2)		4.	5.	4.3	6.	6.	6.
Insulation Resistance (megohms) ambient ( $\times 10^5$ ) 212°F	M	(3) 1., min. 750., min.		3.3 1900.	4.0 2700.	3.6 2300.	9.4 3800.	46.0 8000.	26.5 5900.
pre-m.c. (4)/ambient ( $\times 10^5$ ) m.c. (4)/ambient m.c. (4)/212°F		1., min. 200., min. 200., min.		4.4 73. $\times 10^3$ 1000.	4.6 86. $\times 10^3$ 1300.	4.5 78. $\times 10^3$ 1100.	--- 79. $\times 10^3$ 860.	--- 96. $\times 10^3$ 1130.	--- 88. $\times 10^3$ 980.
pre-rprd./ambient ( $\times 10^5$ ) rprd./m.c. (4)/ambient rprd./m.c. (4)/212°F		1., min. 200., min. 200., min.		3.7 48. $\times 10^3$ 620.	4.6 51. $\times 10^3$ 650.	4.1 49. $\times 10^3$ 623.	--- 77. $\times 10^3$	--- 82. $\times 10^3$	--- 80. $\times 10^3$
pre-vac./ambient ( $\times 10^5$ ) vac. (5)/m.c. (4)/ambient vac. (5)/m.c. (4)/212°F		1., min. 200., min. 200., min.		2.2 59. $\times 10^3$ 580.	2.4 81. $\times 10^3$ 820.	2.3 73. $\times 10^3$ 740.	--- --- ---	--- --- ---	--- 100. $\times 10^3$ 960.
Tear Strength (lb/in)	M T	15., min. 25., min.		14.	20.	16.	11.	14.	13.
Tensile Strength (psi)	T	350., min.		90.	160.	130.	84.	98.	90.
Elongation (%)	T	125., min.		80.	130.	118.	120.	140.	130.
Shrinkage (%)	M	1., max. (opaque) 3., max. (clear)		--	--	<1.	--	--	<1.
Hardness (after full cure)	M	30.-85. (Shore A)		72.	75.	74.	60.	68.	65.
Clarity	T	Water clear		o p a q u e			o p a q u e		
Viscosity, 77°F (poises) (catalyzed)	T	100. to 6,000.		--	--	5460.	52.8	56.5	--
Specific Gravity	T	1.25, max.		--	--	1.77	1.65	1.69	1.67

1. 34-59 mils thick.

2. Based on average value out of 5 for each specimen.

3. Based on average value out of 4 for each specimen.

4. Moisture cycle (m.c.): 75-160°F/95% R.H./1 day per cycle/5 days.

5. Vacuum (vac): NAS 9-8750:  $1 \times 10^{-4}$  torr/ ambient temp./24 hrs.;NAS 9-11068:  $1 \times 10^{-6}$  torr/150°F/24 hrs.

6. T....Target Value M....Mandatory Value.

7. Statement of Work, NAS 9-11068.

TABLE 7-13

## FINAL SCREENING FLAMMABILITY TEST

- Conditions/Results -

Furan Ident. No. MSC S/N WSTF (1) Ident. No. Formulation Type	Requirement (2) ---	596-2-3 6250 73-4343 silicone	600-2-3 6247 73-4340 epoxy	590-6-3 6249 73-4342 epoxy- urethane	602-1-3 6248 73-4341 epoxy- urethane	596-2-3 6265 silicone	600-2-3 6263 epoxy	590-6-3 6264 epoxy- urethane	602-1-3 6262 epoxy- urethane
Atmosphere (psia)									
Oxygen	3.0	3.0	3.0	3.0	3.0	14.7	14.7	14.7	14.7
Nitrogen	7.0	7.0	7.0	7.0	7.0	air	air	air	air
Ignitor	silicone	propane	propane	propane	propane	propane	propane	propane	propane
Specimen Geom. (L"xW"xH")	12.x2.5.x?	5.x2.5x0.075	5.x2.5x0.100	5.x2.5x0.081	5.x2.5x0.075	9.x2.5x0.085	8.5x2.5x0.1	8.x2.5x0.080	8.x2.5x0.075
Flame Propagation Rate (in./sec.) min.	---	0.14	0.07	0.13	0.14	0.0	0.0	0.0	0.0
max.	---	0.17	0.09	0.18	0.17	0.0	0.0	0.0	0.0
ave.	---	0.16	0.08	0.16	0.15	0.0	0.0	0.0	0.0
spec. no.	---	3	3	3	3	3	3	3	3
Self-extinguishing	Yes	?	?	?	?	Yes (3)	Yes	Yes (3)	Yes (3)
Burn Length (in.)	---	?	?	?	?	0.1	2.6	0.27	0.6
Burn Time (sec.)	---	?	?	?	?	13.3	63.	14.6	20.
Flame Color	---	orange	orange	yel.-orange	orange	orange glow	orange	orange	orange
Smoke/Soot	---	profuse	profuse	profuse	profuse	little	profuse/little	little	little
Sparks	---	none	some	none	none	none	some	none	none
Mass Transfer	---	none	melted, dripped	none	none	none	melted, dripped	none	none
Residue - type	---	black, brittle	black, sticky	bl./wht., brittle	black, brittle	bl./wht./ brn. soot	black, soft	black, soft	black char, brittle/soft
- amount	---	some	some	profuse	profuse	little	little	little	little

1. NASA-MSC, White Sands Test Facility.

2. Appendix A, para. 3.4.1.

3. Self-extinguished when ignitor flame removed.

TABLE 8-1

## CARBON MONOXIDE (CO) (1) AND TOTAL ORGANICS (TO) (1)

- Conditions/Results -

Furane Ident. No.	596-1-4B	600-1-1	600-1-4B	590-5-4B
JSC (2) Log No.	6308	6311	6310	6309
WSTF (3) Ident. No.	73-4378	73-4381	73-4380	73-4379
Material Type	Silicone RTV	Epoxy	Epoxy	Epoxy-Urethane
Preconditioning	none	vac/ht (4)	none	vac/ht (4)
Test Chamber Vol. (liters)	4	4	4	4
Loading Conditions				
Gas	O <sub>2</sub>	O <sub>2</sub>	O <sub>2</sub>	O <sub>2</sub>
Pressure (psia)	4.3	4.3	4.3	4.3
Temperature (°F)	ambient	ambient	ambient	ambient
Exposure				
Time (hours)	72.	72.	72.	72.
Pressure (psia)	5.0	5.0	5.0	5.0
Temperature (°F)	155.	155.	155.	155.
Initial Wt. (gm.)	19.9425	20.1257	10.1096	20.3516
Weight Loss (gm./gm.)	0.0009	0.0004	0.0024	0.0009
Weight Loss (%)	0.0045	0.0020	0.0237	0.0044
Carbon Monoxide (μ gm./gm.)	0.1	0.1	1.9	2.4
Total Organics (μ gm./gm.)	42.0	3.4	52.0	51.2
(7)				
Constituents Analysis				
(μ gm./gm.)				
Chloroethane				1.
Bromoethane				80.
TF - Freon	4.	2.		50.
Ethyl Alcohol				20.
Acetone			2.	0.7
Methyl Ethyl Ketone			10.	9.
Benzene	2.		10.	10.
Chlorobenzene				350.
Toluene			30.	1.
Xylene		0.8	40.	0.6
Chlorinated unsat.			2.	3.
C5 alcohol				0.9
Chlorinated unsat.			5.	6.
C6 alcohol				2.
Siloxane dimer	160. (5)	2.		5.
Siloxane trimer		10., <29.		
		(6)		
Trisiloxanes	30., >20.			
	(6)			
Tetrasiloxane	10., <20.			
	(6)			
No. unidentified/each	-1 >20. (6)	4 <1.	4 <1.	4 <0.3
				4 <0.9

1. NASA-MSC D-NA-0002, Test Method No. 6 (see Appendix H).

2. Johnson Space Center.

3. NASA White Sands Test Facility.

4. 10<sup>-6</sup> torr vac./150°F/8. hrs.

5. Identification uncertain.

6. Infrared scan.

7. Based on pentane equivalents.

TABLE 8-2  
ODOR TEST (1)

- Conditions/Results -

Furane Ident. No.	596-1-4B		600-1-1		600-1-4B		590-5-4B	
JSC (2) Log No.	6308		6311		6310		6309	
WSTF (3) Ident. No.	73-4378		73-4381		74-4380		73-4379	
Material Type	Silicone RTV		Epoxy		Epoxy		Epoxy-Urethane	
Preconditioning	none	vac/ht (4)	none	vac/ht (4)	none	vac/ht (4)	none	vac/ht (4)
Material per Liter (gm.)	5.154	5.19	5.0	5.1	5.2	5.13	5.17	5.05
Test Chamber Vol. (liters)	2	2	2	2	2	6	2	6
Loading Conditions								
Gas, N <sub>2</sub> /O <sub>2</sub> (%)	80./20.	80./20.	80./20.	80./20.	80./20.	80./20.	80./20.	80./20.
Pressure (psia)	11.0	11.0	11.0	11.0	11.0	11.0	11.0	11.0
Temperature (°F)	ambient	ambient	ambient	ambient	ambient	ambient	ambient	ambient
Exposure								
Time (hours)	72	72	72	72	72	72	72	72
Pressure (psia)	12.4	12.4	12.4	12.4	12.4	12.4	12.4	12.4
Temperature (°F)	120	120	120	120	120	120	120	120
Dilution with Oxygen								
1:29	0.0	0.0	(5)	(5)		(5)	(6)	(7)
1:9	0.4	0.0	0.4	0.2	0.4	0.4	0.6	0.2
1:1	0.8	0.0	0.2	0.8	1.8	0.6	0.5	0.4
			2.2	2.0	2.4	1.4	0.2	1.8
					(8)	(9)		(10)

1. NASA NHB 8060.1, Test Method No. 6 (average of 5 member panel) (see Appendix I).

2. Johnson Space Center.

3. NASA White Sands Test Facility.

4. 10<sup>-6</sup> torr vac./150°F/8. hrs.

5. Diluted 1000. ml. concentrate to 1000. ml. air to meet WSTF safety requirements.

6. " 134. " " 5866. " " " " " " " "

7. " 180. " " 820. " " " " " " " "

8. One panel member suffered nasal irritation with blood spots.

9. Three panel members suffered from blisters in nasal passages.

10. One panel member suffered blisters in nasal passages.

TABLE 8-3

## VACUUM EFFECTS: SILICONE RTV

- Conditions/Results - (1)

Furane Ident. No. JSC (2) Log No. WSTF (3) Ident. No.	596-1-4B (NV) (4) 6308 73-4378			596-1-4B (V) (5) 6308 73-4378		
Sample	1	2	ave.	1	2	ave.
Initial wt. (gm)	0.256019	0.255623		0.250418	0.256862	
Final wt. (gm)	0.255474	0.255038		0.249910	0.256304	
Wt. loss (gm)	0.000545	0.000585		0.000508	0.000558	
Wt. loss (%)	0.2128	0.2288	0.2208	0.2028	0.2172	0.2100
Final collector wt. (gm)	1.971851	2.394900		(7)	1.847380	
Initial collector wt. (gm)	1.971849	2.394903		1.627054	1.847600	
Collector wt. gain (6) (gm)	0.000002	-0.000003		---	-0.000220	
Collector wt. gain (6) (%)	0.0007	(-)	< 0.007	---	(-)	(-)

1. Test environment (NASA SP-R-0022) (see Appendix J):  
 Final pressure:  $4. \times 10^{-6}$  torr  
 Time: 24. hours  
 Sample temp.: 150.°F  
 Condenser temp.: 77.°F
2. Johnson Space Center
3. NASA White Sands Test Facility
4. Preconditioning: 24. hours/ambient temperature/50.% relative humidity
5. Preconditioning:  $10^{-6}$  torr vac./150.°F/8. hrs.  
 24. hours/ambient temperature/50.% relative humidity
6. Volatile condensable material (VCM)
7. Collector plate was damaged during removal from test fixture after testing.



TABLE 8-4  
VACUUM EFFECTS: EPOXY-URETHANE

- Conditions/Results - (1)

Furane Ident. No. JSC (2) Log No. WSTF (3) Ident. No.	590-5-4B (NV) (4) 6309 73-4379			590-5-4B (V) (5) 6309 73-4379		
Sample	1	2	ave.	1	2	ave.
Initial wt. (gm)	0.250094	0.259049		0.246884	0.248081	
Final wt. (gm)	0.248919	0.257834		0.245537	0.246466	
Wt. loss (gm)	0.001175	0.001215		0.001347	0.001615	
Wt. loss (%)	0.4698	0.4690	0.4694	0.5456	0.6509	0.5982
Final collector wt. (gm)	1.945995	1.715551		1.724055	2.013505	
Initial collector wt. (gm)	1.945988	1.715535		1.724203	2.013545	
Collector wt. gain (6) (gm)	0.000007	0.000016		-0.000143	-0.000040	
Collector wt. gain (6) (%)	0.0027	0.0061	0.0044	(-)	(-)	(-)

1. Test environment (NASA SP-R-0022) (see Appendix J):  
 Final pressure:  $4. \times 10^{-6}$  torr  
 Time: 24. hours  
 Sample temp.: 150.°F  
 Condenser temp.: 77.°F
2. Johnson Space Center
3. NASA White Sands Test Facility
4. Preconditioning: 24. hours/ambient temperature/50.% relative humidity
5. Preconditioning:  $10^{-6}$  torr vac./150.°F/8. hrs.  
 24. hours/ambient temperature/50.% relative humidity
6. Volatile condensable material (VCM)

TABLE 8-5

## VACUUM EFFECTS: EPOXY

- Conditions/Results - (1)

Furane Ident. No. JSC (2) Log No. WSTF (3) Ident. No.	600-1-4B (NV) (4) 6310 73-4380			600-1-4B (V) (5) 6310 73-4380		
Sample	1	2	ave.	1	2	ave.
Initial wt. (gm)	0.252824	0.249394		0.254827	0.248980	
Final wt. (gm)	0.250922	0.247414		0.252780	0.246962	
Wt. loss (gm)	0.001902	0.001980		0.002047	0.002018	
Wt. loss (%)	0.7523	0.7939	0.7731	0.8032	0.8105	0.8068
Final collector wt. (gm)	1.922718	2.188872		1.857127	1.880072	
Initial collector wt. (gm)	1.992736	2.188897		1.857212	1.880663	
Collector wt. gain (6) (gm)	-0.000018	-0.000025		-0.000085	-0.000591	
Collector wt. gain (6) (%)	(-)	(-)	(-)	(-)	(-)	(-)

1. Test environment (NASA SP-R-0022) (see Appendix J):  
Final pressure:  $4. \times 10^{-6}$  torr  
Time: 24. hours  
Sample temp.: 150.°F  
Condenser temp.: 77.°F
2. Johnson Space Center
3. NASA White Sands Test Facility
4. Preconditioning: 24. hours/ambient temperature/50.% relative humidity
5. Preconditioning:  $10^{-6}$  torr vac./150.°F/8. hrs.  
24. hours/ambient temperature/50.% relative humidity
6. Volatile condensable material (VCM)

TABLE 8-6

## VACUUM EFFECTS: EPOXY

- Conditions/Results - (1)

Furane Ident. No. JSC (2) Log No. WSTF (3) Ident No.	600-1-1 (NV) (4) 6311 73-4381			600-1-1 (V) (5) 6311 73-4381		
Sample	1	2	ave.	1	2	ave.
Initial Wt. (gm)	0.248973	0.250551		0.251464	0.255794	
Final wt. (gm)	0.247092	0.248515		0.249467	0.254367	
Wt. loss (gm)	0.001881	0.002036		0.001997	0.001427	
Wt. loss (%)	0.7555	0.8126	0.7840	0.7941	0.5578	0.6759
Final collector wt. (gm)	1.972044	2.506237		1.921703	1.366815	
Initial collector wt. (gm)	1.972045	2.506245		1.921725	1.366776	
Collector wt. gain (6) (gm)	-0.000001	-0.000008		-0.000022	0.000039	
Collector wt. gain (6) (%)	(-)	(-)	(-)	(-)	0.0152	<0.0152

- Test environment (NASA SP-R-0022) (see AppendixJ):  
Final pressure:  $4. \times 10^{-6}$  torr  
Time: 24. hours  
Sample temp.: 150.°F  
Condenser temp.: 77.°F
- Johnson Space Center
- NASA White Sands Test Facility
- Preconditioning: 24. hours/ambient temperature/50.% relative humidity
- Preconditionig:  $10^{-6}$  torr vac./150.°F/8. hrs.  
24. hours/ambient temperature/50.% relative humidity
- Volatile condensable material (VCM)

TABLE 8-7

## VACUUM EFFECTS: SUMMARY (1)

- Conditions/Results - (2)

Furane Ident. No.	596-1-4B (NV) (3)	590-5-4B (NV) (3)	600-1-4B (NV) (3)	600-1-1 (NV) (3)
JSC (5) Log No.	6308	6309	6310	6311
WSTF (6) Ident. No.	73-4378	73-4379	73-4380	73-4381
Material Type	Silicone RTV	Epoxy-Urethane	Epoxy	Epoxy
Weight loss (%)	0.2208	0.4694	0.7731	0.7840
VCM (10) (%)	< 0.0007 (7)	0.0044	< 0.0 (9)	< 0.0 (9)

  

Furane Ident. No.	596-1-4B (V) (4)	590-5-4B (V) (4)	600-1-4B (V) (4)	600-1-1 (V) (4)
JSC (5) Log No.	6308	6309	6310	6311
WSTF (6) Ident. No.	73-4378	73-4379	73-4380	73-4381
Material Type	Silicone RTV	Epoxy-Urethane	Epoxy	Epoxy
Weight loss (%)	0.2100	0.5982	0.8068	0.6759
VCM (10) (%)	< 0.0 (8)	< 0.0 (9)	< 0.0 (9)	< 0.0152 (7)

1. See Tables 8-3, 8-4, 8-5, and 8-6.
2. Test environment:
  - Final pressure:  $4. \times 10^{-6}$  torr
  - Time: 24. hours
  - Sample temp.: 150. °F
  - Condenser temp.: 77. °F
3. Preconditioning: 24. hours/ambient temperature/50.% relative humidity
4. Preconditioning:  $10^{-6}$  torr vac./150. °F/8. hrs.
  - 24. hours/ambient temperature/50.% relative humidity
5. Johnson Space Center
6. NASA White Sands Test Facility
7. One specimen was less than zero.
8. One specimen damaged during test. Second one was less than zero.
9. Both specimen
10. Volatile condensable material (VCM)

TABLE E-8

## TENSILE STRENGTH/ELONGATION AFTER OXYGEN AGING (1)

Material Type	Test Source/ Panel No.		Tensile Strength (psi)		Elongation (%)	
			Initial	Oxygen Aged (2)	Initial	Oxygen Aged (2)
Modified Silicone RTV	Furane F-596-1-19/20	min.	360.	---	370.	---
		max.	450.	---	400.	---
		ave.	396.	---	380.	---
		spec.	5	---	5	---
	WSTF F-596-1-1	min.	340.	341.	380.	375.
		max.	386.	378.	400.	375.
		ave.	368.	360.	393.	375.
		spec.	3	2	3	2
Epoxy-	Furane F-590-2A- 6/19 F-590-4-19/20	min.	1600.	---	130.	---
		max.	1860.	---	140.	---
		ave.	1725.	---	135.	---
		spec.	4	---	4	---
Urethane	WSTF F-590-3-1	min.	1075.	1078.	200.	150.
		max.	1167.	1947.	200.	175.
		ave.	1121.	1467.	200.	167.
		spec.	2	3	2	3

1. Tested per ASTM D412 (Die 'C').

2. Conditioned per ASTM D572 for 96 hours at 300 psi and 156°F.

TABLE 8-9  
OXYGEN IMPACT (1)

- Conditions/Results -

Furane Ident. No. JSC (2) Log No. WSTF (3) Ident. No. Material Type		596-1-1 6312 73-4382 Silicone RTV			590-3-1 6313 73-4383 Epoxy-Urethane		
Impact Energy (ft lb.)	Test Pressure (psia)	Specimens Tested	Reactions	Observations	Specimens Tested	Reactions	Observations
- Mechanical -							
50.	2000.	1	0	no reaction	1	0	no reaction
"	3000.	1	0	" "	1	0	" "
"	4000.	1	0	" "	1	0	" "
"	5000.	4	0	" "	4	0	" "
- Pneumatic -							
---	500	4	0	no reaction	4	0	no reaction
---	1000.	1	1	mild odor - gray resid.	3	1	mild odor - blk. resid.
---	1500.	1	1	" " " " "	1	1	" " " " "
---	2000.	1	1	" " " " "	1	1	" " " " "

1. NASA MSC-PA-D-67-13, Supplementary Test No. A. (See Appendix K.)
2. Johnson Space Center.
3. NASA White Sands Test Facility.

TABLE 9-1

## MODIFIED SILICONE RTV: PRODUCTION FORMULATIONS

Component	S	Formulations (pbw)								
		595-2	605-1	596-6	606-1	607-1	608-1	609-1	610-1	611-1
Sylgard 186	1	100.							100.	
Phos-Chek P/30, Reg.	2	50.						15.38	34.62	
Glass Frit 7570 (1)	3	25.					60.		25.	
F-595-2	6			175.		175.				
F-605-1	6			10.	10.					
F-606-1	6					10.75				
F-609-1	6									26.13
F-610-1	6									159.62
7540 Meteor Cobalt Blue (2)	--				0.75		0.75	0.75		
Sylgard 186 C.A.	1		10.				10.	10.		

S.....Source (see Table 6-2).

1. 325 mesh, predried 48. hrs./212.°F.
2. Harshaw Chemical Co.

TABLE 9-2

## VISCOSITY OF EPOCAST 87517-A/B

F-	EPOCAST	State	Requirement		Test Conditions (2)					
			T/M (1)	Value (poise)	Volume (ml) beaker	mat'l. (4)	Spindle (no.)	Speed (rpm)	Temp. (°F)	Viscosity (poise)
595-2	87517-A	uncat.	(3)	---	600.	450. (4)	6	1.	70.	4340.
"	"	"	(3)	---	600.	450. (4)	6	2.5	70.	3100.
596-6	87517-A/B	catalyzed	T	100.- 6000.	600.	280. (5,6)	6	1.	70.	1760.
"	"	"	"	"	600.	280. (5,6)	6	2.5	70.	1444.

1. T.....Target value      M.....Mandatory value
2. Brookfield Model RVT Viscometer.
3. Test not required by Statement of Work.
4. Material not degassed prior to measurement.
5. Material degassed at 29. in. Hg prior to measurement.
6. No guard, level: 1/8 in. below spindle notch.